Evaluating the Distribution of Environmental and Social Impacts of the Petroleum Refining Industry:

A Preliminary Analysis

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OIL SERVES DIVERSE PURPOSES, including transportation, heating, electricity, industrial production, and as an input into more than 2,000 end products. It is the most valuable commodity in world trade. The economic and political benefits of the refining industry have been clearly articulated both in the academic literature and in public discourse. Largely absent from this discussion have been the environmental and social costs associated with petroleum refining and the actual distribution of costs among population groups and geographic locations. The purpose of this paper is to present empirical evidence and analysis on the environmental impacts of refining, with a particular focus on the distribution of these burdens among different geographic locations and among socio-economic groups.

Why focus on the petroleum refining industry? First, the refining industry constitutes a significant portion of the United States' economy; second, it produces a significant amount of pollution. Petroleum products alone make up an estimated 40 percent of total U.S. energy in terms of BTU consumption, with almost 90 percent of the BTU consumption attributed to fuel products alone. Of U.S. fuel products, motor gasoline comprises the largest category (43 percent) of total fuel products.[1] In 1997, the U.S. Economic Census listed 242 petro-

leum refining establishments, with annual sales of $158.67 billion and more than 65,000 employees.[2] In terms of environmental behavior, the petroleum industry is one of the most regulated and most persistent violators of federal environmental laws. Nearly all refineries are inspected annually and approximately 25 percent of all inspections result in a state or federal enforcement action.[3] Refineries are also a significant source of toxic chemicals that pose an increased risk to public health. Given the importance of the petroleum refining industry in the U.S. economy and the environmental and social impacts caused by the operation of refineries, it is important to make an assessment of the distributional impact of refinery operations on communities and geographic locations.

The rest of the paper is divided into three sections. Part 1 gives an overview of the petroleum refining industry, focusing on some of the key changes that have taken place in this industry in the last decade, and discusses the regulatory framework for petroleum refineries. Part 2 examines the environmental and health impacts associated with refinery operations. The final section focuses on the distribution of these burdens among socio-economic groups and communities.

INDUSTRY BACKGROUND

Petroleum refining is the separation and processing of crude oil into three types of products: fuels, finished non-fuel products, and chemical industry feedstocks. Petroleum refineries span a total of 32 states, but the industry is heavily concentrated in only a few of them. Most petroleum refineries are located on the West and Gulf coasts, mainly due to access to major sea transportation and shipping routes. Table 1 shows the geographic distribution of petroleum refineries among the states. Refining capacity is also not evenly distributed across refineries. Some of the smallest oil producing states have only very small refineries run by independent operators.

Throughout much of the 1980s and 1990s, the petroleum refining industry experienced significant economic pressures as well as the growing strains of environmental and safety regulations. Because of changes in oil prices, a shift to alternative fuel use, and an increasing focus on conservation, the industry lost several small, inefficient refineries that were no longer competitive. In addition, requirements placed on refineries to produce cleaner fuels coupled with a number of mandates through federal and state clean air and water regulations forced some refineries to shut down. Between 1982 and 1994, the number of operating refineries decreased in the U.S. by approximately 71 percent. Most of this decline was due to the closure of small refineries, although larger refineries also faced the burden of economic pressures.[4] Figure 1 depicts the trend in refinery operations over the last two decades.

Despite refinery closures and widespread opposition to constructing and siting new refineries close to existing communities, the EPA has noted that total crude oil distillation has continued to be constant. This trend is attributed to technological change, which enables firms to increase production without building additional refineries, as well as the application of process engineering to improve the efficiency of the refining process. Since 1980, refinery utilization rates have been constantly increasing. Utilization rates are obtained by dividing the amount of crude oil refined by total refining capacity. In 1985, refinery utilization was 77.6 percent; in 2001 the percentage had increased to 92.3 percent.[5]

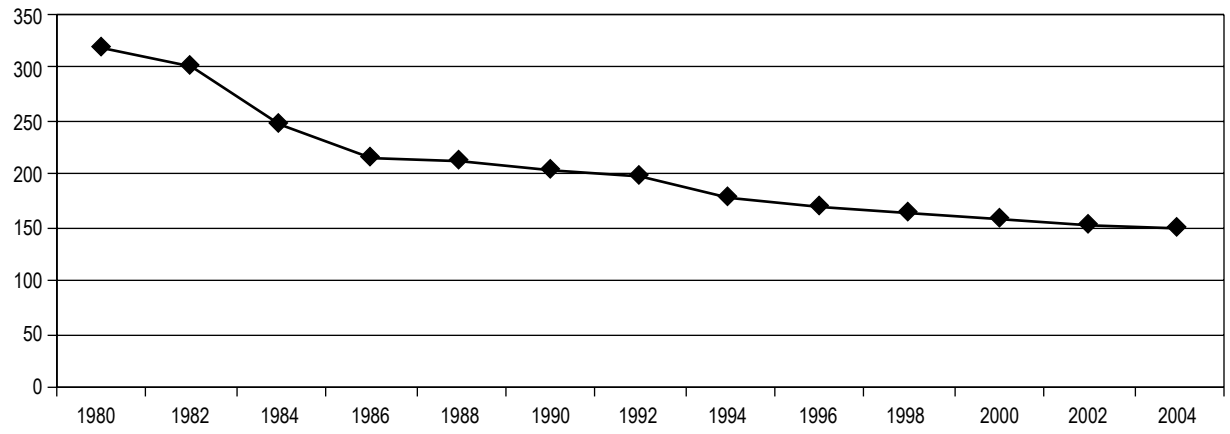
The U.S. petroleum refining industry is now composed of a relatively small number of large facilities. The majority of oil distillation capacity is centered in large, integrated companies with multiple refining facilities. According to 2002 data, 72 companies operated refineries, of which the largest companies were: ExxonMobil (11 percent of crude capacity), Philips 66 (10 percent), BP (9 percent), ChevronTexaco (6 percent), Marathon Ashland (6

Table 1
Number of Operable Petroleum Refineries by State as of Jan. 1, 2004

State	No. of Refineries	State	No. of Refineries
Alabama	3	Montana	4
Alaska	6	Nevada	1
Arkansas	2	New Jersey	6
California	21	New Mexico	3
Colorado	2	North Dakota	1
Delaware	1	Ohio	4
Georgia	2	Oklahoma	5
Hawaii	2	Pennsylvania	5
Illinois	4	Tennessee	1
Indiana	2	Texas	26
Kansas	3	Utah	5
Kentucky	2	Virginia	1
Louisiana	17	Washington	5
Michigan	1	West Virginia	1
Minnesota	2	Wisconsin	1
Mississippi	4	Wyoming	5

Source: Energy Information Administration/Petroleum Supply Annual 2003, vol. 1.

Figure 1
Number of U.S. Operating Refineries



Source: Energy Information Administration. Online. Available: http://www.eia.doe.gov/emeu/aer/tst/ptb0509.html.

percent), Valero (5 percent), and Motiva (5 percent), which combined represent 52 percent of crude intake capacity.[6] Each of these companies operates a number of refineries in different states.

Petroleum refining is one of the most heavily regulated industries in the U.S. The environmental impacts of petroleum refining and the use of its products have resulted in a number of environmental laws and regulations. Some of the statutes that have the most impact are those that focus on altering the formulation of products to reduce air emissions generated by their use. These often require substantial changes in refinery processes along with large capital investments. In addition, a number of federal and state regulations focus on reducing refinery emissions to air, land, and water. In other words, petroleum refineries not only have to deal with the environmental impacts of their operations, but also have to face complex regulatory issues regarding their products.

The U.S. petroleum refining industry is regulated under statutes, which include the National Environmental Policy Act; the Clean Air Act's National Emission Standards for Hazardous Air Pollutants, National Ambient Air Quality Standards, New Source Review (NSR), and New Source Performance Standards; the Clean Water Act's National Pollutant Discharge Elimination System and Spill Prevention Control and Countermeasure Requirements; the Emergency Planning and Community Right-to-Know Act; the Underground Injection Control program of the Safe Drinking Water Act; and the Resource Conservation and Recovery Act. Several states have also implemented local environmental standards for the refining industry, which, in general, are stricter than federal standards. California, for instance, has implemented regulations for reformulated gasoline that are stricter than those set forth in the Clean Air Act.[7]

The Clean Air Act of 1970 and its Amendments in 1977 and 1990 have had a significant impact on the petroleum refining industry, both in terms of refining processes and the formulation of refined products. The industry characterizes the Clean Air Act Amendments (CAAA) of 1990 as some of the most burdensome and costly for the petroleum refining industry. A report prepared by the American Petroleum Institute notes that compliance with the CAAA has led to major increase in air-related expenditures. In 1990, the petroleum industry spent $2.3 billion on air-related requirements, and by 1995 this amount totaled nearly $4.6 billion.[8]

The 1970 CAA authorized the EPA to establish the National Ambient Air Quality Standards (NAAQS) for sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, non-methane hydrocarbons, and total suspended particulates in ambient air. Regulatory actions under the CAA required reductions of lead in gasoline in the early 1970s, and elimination of lead in gasoline in the mid-1980s. To meet the lead reduction requirement, refineries incorporated considerable changes in processing to make up for the properties lost as a result of reducing lead based anti-knock additives.[9]

The 1990 amendments increased the stringency of the 1970 Act in response to a growing number of non-attainment areas (geographic regions not in compliance with NAAQS). In addition to increased regulation

of air emissions, the CAAA called for reformulation of motor fuels to reduce mobile source emissions. Title III of the 1990 CAAA requires that EPA develop National Emission Standards for Hazardous Air Pollutants (NESHAPs) for several chemicals, including benzene, emitted by petroleum refineries. Petroleum refineries, which are major sources of hazardous air pollutants (HAPs), must meet these emission standards by the adoption of maximum achievable control technology (MACT) to reduce emissions. In August 1995, EPA finalized requirements for the control of HAPs from most of the process units at refineries. The MACT rule requires that refineries install control equipment on certain process vents that reduces HAPs by 98 percent. Refineries must also implement leak detection and repair programs.[10]

The economic impact of the MACT rule is expected to be substantial. EPA has estimated the capital investment associated with refineries' MACT compliance to be about $213 million. In addition, annual operating and monitoring costs are estimated to be about $79 million.[11] However, roughly $300 million is a small cost when compared to annual industry sales of over $150 billion.

Increased environmental regulation is one of the reasons cited for refinery closures during the 1990s. Department of Energy statistics show that in 2000 there were only 158 operating petroleum refineries in existence, and 29 refineries shutdown throughout the 1990s.[12] In August 2000, the EPA settled on new regulations capping the sulfur content of fuels, which took effect at the end of 2003. Even before the regulations went into effect, Premcor Inc., an independent refiner, closed its Blue Island refinery in Illinois due to the expense of facility upgrades required to comply with new environmental guidelines.[13]

Environmental and Health Impacts of Petroleum Refining

Notwithstanding the lengthy and complex list of regulations governing the petroleum refining industry, critics of this industry accuse it of taking advantage of loopholes in the existing laws and producing a significant amount of pollution. The EPA has reported significant levels of refinery noncompliance with air regulations, water standards, and solid waste regulations.[14] This section looks at the types of pollution created by petroleum refineries and the environmental and health impacts of that pollution. The evidence and analysis contained in this section is derived from EPA reports, congressional committees' investigations into refinery emissions, and EPA's Toxic Release Inventory database. An important aspect of refinery pollution that is often missed in the information used by EPA is fugitive emissions. We find that this is a significant source of pollution; regulatory authorities such as EPA should not only monitor emissions from regulated smokestacks and effluent pipes, but should also pay close attention to fugitive emissions.

In other words, petroleum refineries not only have to deal with the environmental impacts of their operations, but also have to face complex regulatory issues regarding their products.

Refineries are the second largest industrial source of sulfur dioxide, the third-largest industrial source of nitrogen oxides, and the largest stationary source of volatile organic compounds (VOC) emissions—the precursor to urban smog. The accumulation of refinery air emissions such as hydrocarbons, sulfur dioxide, and particulate matter also contributes to acid rain.

Petroleum refineries also use large quantities of chemicals during the processing of crude oil, many of which are toxic. Toxic chemicals are monitored through the Toxic Release Inventory (TRI), instituted under the Emergency Planning and Community Right-to-Know Act (EPCRA). Under the TRI, companies are asked to report on how they manage toxic chemicals, including transfers, treatment, disposal, recycling, energy recovery, and releases to land, air, or water. Each refining facility in the U.S. must report annual emissions of roughly 600 listed chemicals. Analysis of the TRI data reveals that in 2001 petroleum refineries released 75 percent of their toxic emissions to air, 24 percent to water (including 20 percent to underground injection and 4 percent to surface waters), and 1 percent to land.[15] The primary hazardous air pollutants released by the industry are benzene, toluene, ethyl benzene, mixed xylenes, and n-heptane.

Petroleum refinery emissions seriously impact human health and the environment. Some of the health impacts associated with exposure to hazardous air pollutants include severe burns, skin and eye irritation from high levels of benzene and

hydrogen sulfide fumes, and increased cancer risks from exposures to benzene, xylene, and arsenic. Apart from this, workers in refineries are at risk of chronic lung disease from long-term exposure to coke-dust, silica, and hydrogen sulfide; headaches and mental disturbances from carbon-monoxide exposures; and psychosis and peripheral neuropathies from exposures to lead alkyls used as gasoline additives.[16]

Since 1988, the petroleum refining industry has made substantial progress in decreasing its chemical releases to the environment. The amount of comparable[17] TRI chemicals released from refineries declined by 14 percent from 1995 to 2000 and by nearly 51 percent since 1988[18]. Table 2 shows the decline in refinery release of 1988 core TRI chemicals by medium.

Fugitive emissions from refineries pose an important threat to the environment and often tend to go undetected, thereby magnifying the problem of air pollution. It has been found that the majority of refinery emissions actually occur through leaks rather than through regulated smokestacks or effluent pipes. In 1999, Congressman Henry A. Waxman commissioned an investigation into fugitive emissions from refineries by the minority staff of the House of Representatives Government Reform Committee.[19] This study, based on a review of enforcement records obtained from the EPA, revealed that oil refineries fail to report large volumes of fugitive emissions. The average refinery reports to state and federal regulators that 1.3 percent of the valves at its facilities have leaks, whereas the average leak rate from valves at refineries is 5.0 percent—four times higher than the average reported leak rate. This failure to detect emissions from leaking valves has a detrimental impact on air quality. The EPA has estimated that the unreported fugitive emissions from refineries add millions of pounds of harmful pollutants to the atmosphere each year, including more than 80 million pounds of VOCs and more than 15 million pounds of toxic pollutants.[20]

The unreported fugitive VOC emissions from refineries significantly impact state and local air quality. Nearly half of these fugitive VOC emissions occur in areas that do not meet federal air quality standards for ozone. Figure 2 shows the ten states that account for more than 75 percent of the unreported VOC emissions. Not surprisingly, air pollution is a significant problem in many of these states. In fact, 40 percent of petroleum refineries operating in the United States in 1998 were located in "non-attainment" areas that do not meet federal air quality standards for one or more pollutants emitted in significant amounts from refineries.[21]

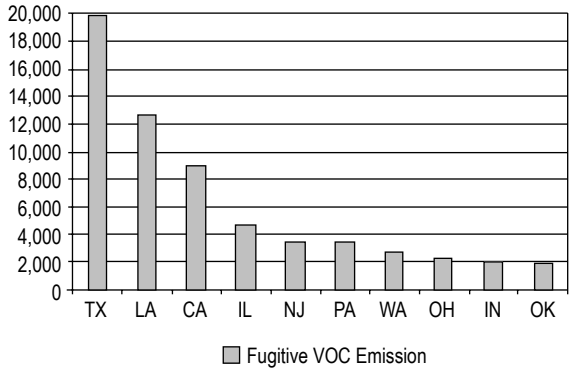
Refineries also use thousands of gallons of water per day for production and cooling processes. Wastewaters are treated in on-site wastewater treatment facilities and then discharged to POTWs (publicly owned treatment works) or discharged to surface water under National Pollutant Discharge Elimination System (NPDES) permits. When refinery wastewaters are released to surface waters, they are regulated under the Clean Water Act (CWA). Limits are placed on the quantities of suspended solids, oil, grease, phenolic compounds, ammonia,

Table 2
Refinery Releases of Comparable TRI Chemicals by Medium: 1988-2000
(in thousands of pounds)

Year	Amount	On-site Releases to Air	On-site Releases to Water	On-site Releases to Land	On-site Underground Injection	Off-site Releases
1988	73,863	66,004	752	2,127	528	4,452
1989	72,163	62,722	1,172	1,860	1,589	4,820
1990	66,768	58,435	939	1,998	1,341	4,055
1991	58,781	53,738	614	717	1,324	2,388
1992	62,958	53,955	705	4,931	1,084	2,283
1993	51,849	47,862	574	643	732	2,039
1994	46,643	42,011	468	590	718	2,855
1995	42,403	38,149	516	190	897	2,651
1996	43,417	38,952	423	1,188	1,000	1,854
1997	42,856	37,031	516	1,682	1,032	2,595
1998	42,026	36,544	395	442	1,352	3,293
1999	37,419	32,091	336	420	1,103	3,470
2000	36,486	29,721	467	511	648	5,139

Source: Suriano, Robert. Toxics Release Inventory: 1988-2000 Data. Washington, D.C.: American Petroleum Institute, 2003, p.10. Online. Available: http://api-ep.api.org/filelibrary/Final%20TRI%2000%20May03.pdf. Accessed: February 21, 2006.

Figure 2
States Most Affected by
Unreported Fugitive VOC Emissions
(in thousands of pounds)



Source: Oil Refineries Fail to Report Millions of Pounds of Harmful Emmissions, 1999. Online. Available: http://www.democrats.reform.house.gov/Documents/20040827114147-65907.pdf

sulfides, and chromium that may be present in the wastewater.[22] Treatment of liquid effluent does not entirely eliminate contaminants such as aromatic hydrocarbons (benzenes and napthenes) that enter surface waters. For instance, a recent study of water pollution from petroleum refineries found significant levels of aromatic hydrocarbons that contributed to important differences in the diversity and abundance of fish between stations located up- and downstream from refineries.[23]

Given the significant emissions of pollution by petroleum refineries to air, the EPA launched its Petroleum Refinery Initiative in 1998—a multifaceted approach to review the petroleum refining industry's compliance with the CAA. This initiative addresses four priority areas that represent the most important noncompliance problems at petroleum refineries: (a) New Source Review / Prevention of Significant Deterioration, (b) New Source Performance Standards, (c) Leak Detection and Repair, and (d) Benzene National Emissions Standards for Hazardous Air Pollutants. The EPA uses legal settlements known as consent decrees to resolve decades of alleged pollution violations. In return for installing pollution controls and paying fines, companies are released from all legal liability associated with the four priority areas.

EPA initiated scores of investigations at refineries, each focusing on at least one of the priority areas. The agency embarked on a series of innovative, multi-issue, multi-facility settlement negotiations with major petroleum refining companies. Since March 2000, EPA has entered into 16 global settlements with petroleum refiners that together represent more than 65 percent of domestic petroleum refining capacity. The settlements now cover 76 refineries and will result in an annual reduction of atmospheric emissions of approximately 70,000 tons of nitrogen oxide and 195,000 tons of sulfur dioxide. The settlements also require significant emissions reductions of benzene, volatile organic compounds, and particulate matter. The settling refining companies agreed to invest more than $3.8 billion in control technologies and pay $55 million in civil penalties. They will also perform supplemental environmental projects valued at approximately $50 million.[24]

Though the EPA declared the Petroleum Refinery Initiative one of the most comprehensive and successful enforcement efforts, in reality it has not achieved the air quality improvements that the agency has claimed. A review of oil company data submitted to the EPA and interviews with oil company officials reveal that the program, by December 2004, had resulted in annual reductions of no more than 40,000 tons of nitrogen oxide, sulfur dioxide, and particulate matter, the primary pollutants targeted by the initiative.[25] The ambitious figures quoted by EPA will be achieved only when the pollution controls contained in the consent decrees are actually implemented. Of the deadlines set for refineries to reduce their emissions under the program, about two-thirds have been extended. In fact, an evaluation report conducted by the U.S. Office of Inspector General states that EPA "has not established and communicated clear goals, systematically monitored refinery program progress, reported actual outcomes, or tracked progress toward achievement of consent decree goals. In addition, during consent decree implementation, EPA delays may have delayed emissions reductions and compromised compliance."[26]

DISTRIBUTIONAL AND REGULATORY IMPACTS ASSOCIATED WITH PETROLEUM REFINERIES

The previous section outlined some of the environmental and health impacts, including air pollution and water pollution, from refinery activities. This section will examine the distributional burden of refinery activities among communities, within their population groups, and in different geographic locations. In addition, this section will make a preliminary assessment of regulatory enforcement across minority communities and different states. EPA's

Enforcement Compliance History Online (ECHO) database was used to make these assessments.

ECHO provides compliance and enforcement information for approximately 800,000 regulated facilities nationwide. The ECHO database reports compliance and inspection data, chemical releases and spills, and, interestingly, demographics of the surrounding population. By combining TRI data with inspection reports and demographic data, the ECHO database is a unique resource for evaluating the distribution of impacts from petroleum refineries. ECHO indicates a facility's record of compliance with the Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act covering the past three years.

Throughout the 1990s, the EPA targeted petroleum refineries as its top enforcement priority. According to the EPA, in 1999, 54 percent of refineries were in "significant non-compliance" with the Clean Air Act; 22 percent were in significant non-compliance with the Clean Water Act; and 32 percent violated the Resource Recovery and Conservation Act.[27] During 2002-2005, refineries were in non-compliance with the CAA, CWA, and RCRA for an average of 17.5 quarters.[28] Refineries, on average, were in non-compliance with CAA for 9 quarters, with CWA for 4 quarters, and with RCRA regulations for 4.5 quarters over the three-year period.

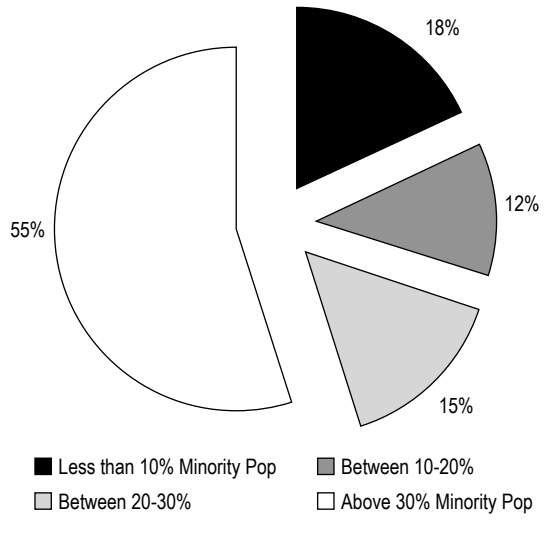
Interestingly, during 2002-2005, 95 refineries out of 144 (66 percent) were classified as High Priority Violators (HPV) with respect to the CAA, while only 14 refineries were in "Significant Non-Compliance" (SNC) with the CWA and RCRA. To be classified as HPV or SNC, one of several conditions must be met: failing to submit a major report, violating an administrative or judicial order, failing to obtain a Prevention of Significant Deterioration permit for categorization as HPV, violating an allowable emission limit detected during a source test or chronic/recalcitrant violations, causing actual exposure (or a substantial likelihood of actual exposure) to hazardous waste, or being a reckless violator deviating substantially from the terms of an arrangement with the EPA.

Given that refinery compliance with the CAA seems to be a problem area, one would expect that more inspections would be directed to check a refinery's record of compliance with CAA regulations. Surprisingly, out of a total of 1388 inspections for the period 2002-05 for 144 refineries, 371 (26.7 percent) inspections were under the CAA while 437 (31.5 percent) and 580 (41.8 percent) inspections were under CWA and RCRA respectively. It is preliminary to speculate about the reasons for the disproportionate emphasis on land and water versus compliance with air regulations. This is an issue that we expect to explore further in our research.

A simple analysis of data from EPA's ECHO shows that more than half the refineries (55.3 percent) are located within a three-mile radius of communities with dominant minority population (those communities with more than 30 percent minority populations).[29] Figure 3 presents a simple breakdown of distribution of refineries with respect to minority populations living in close proximity to refineries in the United States. In addition, 48.7 percent of High Priority Violator refineries are situated within a three-mile radius of communities with more than a 30 percent minority population.

Local communities have documented, largely through anecdotal reports, variations in regulatory enforcement. Analysis of data from ECHO shows that inspection levels tend to decrease as one goes from predominantly white communities to predominantly minority communities. Table 3 presents data on the number of refineries, total inspections, and average inspections with respect to communities characterized by the percent of their minority population. The same data are presented in Figure 4 as a scatter plot. The relatively larger number of inspections for refineries situated within three miles of communities with 60-80 percent minorities is due to a high incidence of inspections of two refineries:

Figure 3
Percentage of Refineries within 3 Miles of Minority Populations



Source: EPA, ECHO database. Online. Available: http://www.epa.gov/echo/.

Table 3
Incidence of Inspections Relative to Percentage of Minorities Living Within 3 Miles of a Refinery

Minority Pop Category (within 3 mile area of refinery)	Number of Refineries	Total Inspections	Average Inspections
Less than 20%	40	430 (37.9%)	10.8
Between 20%-40%	35	272 (23.9%)	7.8
Between 40%-60%	19	125 (11.0%)	6.6
Between 60%-80%	18	205 (18.1%)	11.4
Above 80%	20	104 (9.2%)	5.2
Total	132	1136	8.6

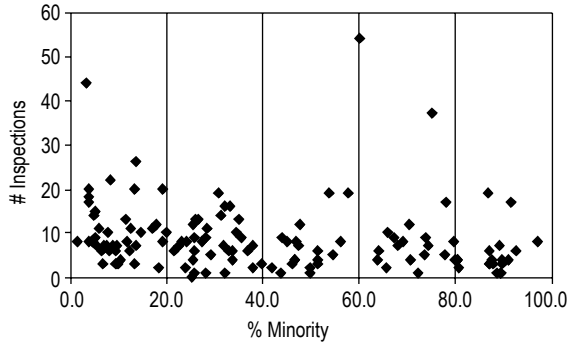
Source: EPA, ECHO database. Online. Available: http://www.epa.gov/echo/. (Excludes refineries in Alaska and Hawaii.)

BP's refinery in Whiting, Indiana, had 54 inspections during 2002-05, while Colorado Refining Co. had 37 inspections during that period.[30] If we drop these two refineries from our analysis, the average inspection number drops down to 7.1.

Studies focusing on the association between race, income, and penalties assessed against companies violating environmental laws are mixed. A recent research paper on penalties in the petroleum industry finds mixed evidence of inequality depending upon the racial and income characteristics of communities surrounding the penalized refinery. Controlling for enforcement history, firm characteristics, and political/economic climate, this study finds evidence of inequity in the case of Hispanic and low-income communities only if ZIP codes rather than census tracts are used to obtain the demographic data. [31]

Levels of enforcement on petroleum refineries also seem to vary widely across states. A study conducted by the Environmental Defense Fund in 1995 found that states vary greatly in their regulatory and enforcement efforts to reduce multi-media waste releases and off-site waste transfers for refineries. The states identified with the poorest performance are West Virginia, Kansas, Texas, and Mississippi. At the other end, New Jersey, with its more extensive right-to-know reporting requirements, was ranked as the most efficient state.[32] A report by the Sustainable Energy and Economic Development (SEED) Coalition asserts that Texas and Louisiana, the largest oil refining states, have the weakest enforcement agencies.[33]

Figure 4
Incidence of Inspections



Source: EPA, ECHO database. Online. Available: http://www.epa.gov/echo/

Examination of ECHO inspection data by state seems to lend support to this assertion. Though Texas, California, and Louisiana have the highest concentration of refineries, the average number of inspections of refineries located in these three states is very low compared with other states. Table 4 shows variation in refinery inspections across different states in the last three years. Based on the data, states with a higher average number of inspections are Montana, Illinois, Indiana, and Colorado. Delaware seems to be an outlier case with 130 inspections directed against a single refinery in the last three years. Texas and California, with 28 and 23 refineries respectively, fare very poorly in terms of their inspection rate.

CONCLUSIONS, FURTHER RESEARCH

The impact of the petroleum refining industry is significant and widespread. This paper has attempted to take a first pass at examining the environmental, social, and health impacts of the refining industry, focusing on the distribution of these burdens among minority communities and variation in enforcement actions across communities and states. EPA's ECHO has been used to support the analysis of distributional costs of refinery operations among population groups and geographic locations. The analysis presented in the paper seems to indicate a correlation between minority communities and

Table 4
Variation in State Inspection of Refineries, 2002-05

State (no. of refineries)	Total Inspections	Average Inspections	State	Total Inspections	Average Inspections
Michigan (1)	1	1	West Virginia (1)	9	9
New Mexico (3)	8	2.66	Wyoming (5)	45	9
Washington (5)	18	3.6	Arkansas (2)	19	9.5
California (23)	102	4.43	Kentucky (2)	19	9.5
Mississippi (4)	22	5.5	New Jersey (6)	65	10.83
Texas (28)	164	5.85	Louisiana (17)	204	12
Tennessee (1)	6	6	Pennsylvania (5)	68	13.6
Virginia (1)	6	6	Georgia (2)	28	14
Kansas (3)	19	6.33	North Dakota (1)	15	15
Utah (5)	33	6.6	Montana (4)	62	15.5
Alabama (4)	27	6.75	Illinois (4)	87	21.75
Wisconsin (1)	7	7	Indiana (2)	67	33.5
Ohio (4)	28	7	Colorado (2)	85	42.5
Oklahoma (5)	35	7	Delaware (1)	130	130

Source: EPA, ECHO database. Online. Available: http://www.epa.gov/echo/.

regulatory enforcement. In addition, there is some evidence of variation in inspections of refineries across the different states. While one would expect states like Texas, California, and Louisiana, with the highest concentration of refineries, to be more stringent with respect to inspections, the data do not support that expectation. These data, while preliminary, make clear the need for accounting for these variations in the implementation of environmental regulations in any future research.

Significant research is required to better understand, measure, and evaluate impacts of the petroleum refining industry on the environment and on communities living in proximity of such facilities. While oil is at the center of current economic activities, it is also at the heart of some of the most troubling environmental and health problems. Hence it is critical to understand the distribution of impacts of oil and the effectiveness of current regulation systems in reducing the impacts and their disparity. Additional research needs to examine issues of compliance and enforcement records for polluting industries, including factors affecting the compliance of companies with environmental regulations and those affecting the enforcement actions of regulatory agencies.

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NOTES

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