Corporate Environmental Behavior and the Effectiveness of Government Interventions

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SESSION III: APPROACHES TO ENVIRONMENTAL PERFORMANCE

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Session III: Approaches to Environmental Performance

A Multi-Agent Model of a Small Firm

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This paper presents a bottom-up view of industrial ecosystems by examining the interpersonal dynamics that influence corporate environmental behavior. Employees of profit-making firms don't always behave in the shareholders' best interests due to misaligned incentives, impaired information flows, and bounded rationality. Even worse, there are sometimes conflicts between shareholder interests and the broader public interest, evident in the moral struggles of people over their dual roles as employees and as citizens. Employees operate within the formal, regulative structures of the firm and government, as well as the informal, normative or cultural structures of social networks.

The paper triangulates to identify useful insights about personal networks and corporate environmental behavior, using interviews at firms, review of archival data, and a computer simulation model. Interviews and archival data provide empirical grounding, while an innovative multi-agent simulation modeling exercise supports formal theorizing. The empirical work is based on case studies of plastics processing firms in New Jersey. The simulation model characterizes production technologies, social and economic structures, and interpersonal interactions under a variety of conditions. The model may eventually prove helpful to managers interested in improving on existing organizational practices and procedures. The model could also help regulators understand corporate environmental behavior more fully.

Findings are relevant to both the eco-park and industrial ecosystem levels of analysis. This work is funded by a U.S. Environmental Protection Agency STAR grant.

The next section reviews the relevant literature. Then the paper provides an introduction to the industrial sector studied, describes case studies of four firms and findings from those cases, introduces the multi-agent simulation model and modeling processes, and draws conclusions.

Literature on networks and organizations

Studying organizations

It is difficult to study organizations because they are so highly complex and adaptive. They exhibit structural complexity, having both functional and product hierarchies within whose mesh individual employees act. Organizations are also goal-oriented systems that survive by adapting to changing external conditions. The leaders of organizations work full time to change that which researchers study.

The range of organizational phenomena is rich enough that distinct disciplinary approaches to their study have developed. Often researchers talk past rather than to one another over interstitial issues such as linking structure and agency. The normal progressive spiral of science from induction to deduction, pattern matching to hypothesis testing, evidence to theory and back again, seems to operate inefficiently. Many theories co-exist, and empirical work fails to eliminate most of these rivals. This paper attempts to get the "wheel of science" (Wallace, 1971) spinning productively by directly triangulating across extant theory, qualitative data, quantitative data, and simulation modeling.

As discussed elsewhere (Andrews, 2001), there is much useful economic theory for industrial ecologists to draw upon. It explains why firms exist (scale economies, transaction cost reductions), how they respond to changing external conditions (internal structural change, external influence projection), and how they relate to other firms (contracting, mixed-motive strategizing). Some strands of the contracting literature also assign agency to employees within a firm, typically highlighting mismatched incentives and informational asymmetries.

Prescriptive management theories have progressed over time from the efficiency studies of Taylorism, to classical management theory that emphasized commanding and controlling, to the gentler and more respectful human relations approach of Mayo, to the systems approach of Senge and others.

Classical and neoclassical economic theories provide an atomized explanation of economic actions, whereas reformist economists view economic actions as embedded within social structures. According to these theories social relations between individual actors impedes competitive markets and individuals pursue a narrow utilitarian, self-interest. This view is called "undersocialization". "Oversocialization" is when behavioral patterns are so internalized that social relations have only a peripheral effect on behavior.

Granovetter (1985, 487) posits a middle position between over and under socialization "*Actors do no behave or decide as atoms outside a social context, nor do they adhere slavishly to a script written for them by the particular intersection of social categories that they happen to occupy. Their attempts at purposive action are instead embedded in concrete, ongoing systems of social relations*." He furthermore rejects the neoclassical undersocialization theory arguing that "*anonymous markets of neoclassical models are virtually nonexistent in economic life and that transactions of all kinds are rife with the social connection*." In actuality, business relations today are mixed up with social relations all the time. For example (p. 496), "*in industrial purchasing, buying and selling relationships rarely approximate the spot-market model of classical theory…and evidence consistently suggests that it takes some kind of 'shock' to jolt the organizational buying out of a pattern of placing repeat orders with a favored supplier.*" The reasons for this type of seemingly irrational behavior include costs associated with searching for new suppliers and establishing new relationships. These relationships are formed through trade associations, country clubs, and other social gatherings. The survival and success of small firms in the market are in part due to a dense network of social relations overlaid on top of the business relations that connects such firms and reduces pressures for integration.

Social Networks

There is a distinction between the 'formal' and the 'informal' organization of the firm with the formal represented by the organizational chart and the informal represented in the social networks within the firm. Organizational charts do not reflect the way the work gets done inside an organization. There are many actors in employees' social networks, all of whom have the potential to influence the employee. There are two main types of actors that have this influence, and Shah (1998, p.250) call them "*cohesive and structurally equivalent actors.*" Cohesive actors or referents are individuals with close, interpersonal ties, or friends. Structurally equivalent actors are individuals who share a similar pattern of relationships with others and thus occupy the same position in a network. Shah (1998, p.249) has shown that "*employees rely on structurally equivalent referents for job related information and on cohesive referents for general organizational information and as social comparison referents.*"

Informal practices and social networks serve distinct purposes within a firm. For example, firms' internal information is not necessarily acted upon, particularly in the context of promotion practices. According to Granovetter (1985, 499), "*internal promotions have affirmative incentive properties because workers can anticipate that differential talent and degrees of cooperativeness will be rewarded*." Long term employees also have built up strong informal networks within the firm (Granovetter, 1985, 501), "*when many employees have long tenures, the conditions are met for a dense and stable network of relations, shared understandings, and political coalitions to be constructed*."

Individuals are more likely to obtain general organizational information (i.e. office gossip, organizational culture, office politics) from cohesive actors, according to Shah (1998, p.252). Social comparison theory suggests that similarity plays an important role in referent selection. Demographic variables such as gender, age, tenure, and education account for different aspects of similarity within workplaces. People often select referents of the same gender, job category and education. Similarity in tenure and age may also serve as relevant dimensions for career comparisons. In the cases studies to follow, there is some evidence that long tenure and seniority on the job elicits greater influence in the work environment than simple hierarchical positions. The studies also show that there is greater cohesion in the workforce because of the similar ethnic backgrounds of the low skilled workers of Hispanic origin. This demographic trait is also a link to higher levels in the organization through internal promotions.

Workplace uncertainty, socialization practices and performance ambiguity may all lead to different types of socialization within the firm. A routine, well-defined assembly line task may elicit few inquiries regarding job responsibilities and performance. More complex, loosely structured positions may generate many inquiries. The plastics manufacturing firms included in this case study would fall under the category (Toone and Jackson) of small batch production or "job-order manufacturing for customized products in which production is done according to demand in small runs and lots."[1]

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[1] Toone, Roland and Jackson, Dave. 1987. The Management of Manufacturing: The competitive Edge. Springer-Verlag; New York, p. 22

Formal vs. Informal networks

According to Scott (2001, 153), there are two distinct features of firms today. *"First, there exists a remarkable similarity in the structural features of organizational forms operating within the same organizational field…..Second, students of organizations have long observed the presence of both a formal and informal structure, the former reflecting officially sanctioned offices and ways of conducting business, the latter, actual patterns of behavior and work routines. An uneasy tension exists between these structures."* The formal and informal networks that frame inter- and intra-firm behavior are defined as follows by Schermerhorn and colleagues (1988, 199):

- "Formal groups are created via formal authority for some purpose. They typically have rather clear cut superior-subordinate relationships, and they often appear on formal organizational charts." Formal groups are designated by an organizational authority and can be seen in the production pressures and technical demands of a company. Formal groups are specified by the organization chart (and by a task group in a matrix management situation).
- Informal groups on the other hand are not formally recognized but typically consist of subgroups or cliques within formal groups. These informal groups can be people within a firm that eats together or goes on breaks together. Informal groups emerge spontaneously. Informal groups consist of groups of individuals that want to achieve some mutual objective (not the organization's but the group's), sometimes they are merely friendship groups or people who have something in common. According to Scott (2001), "This is really where/how things get done in organizations." Informal groups can be seen in the regulative, normative and cultural-cognitive elements of the company, including company sponsored social activities of the sort mentioned in the case study to follow.

Informal networks exist because they help individuals do their work by "offering a network of interpersonal relationships with the potential to 'speed up' the work flow or gain favors in ways that formal lines of authority fail to provide" (Schermerhorm et al, 1988, 200). These informal groups also help individual employees meet needs beyond what the formal groups can provide, including:

- Social satisfaction – friendship and social relations
- Security - "opportunities to find sympathy for one's feelings and actions, especially as they relate to friction with the formal organization; opportunities to find help or task assistance from persons other than one's superior"
- Identification – sense of belonging by associating with people who are similar

Organizational life cycle

As organizations increase in size, they typically become more heterogeneous in their orientations and in the products and services they provide. This often results in movement from a simple to a more complex structure.

Organizational Life Cycle Entrepreneurial Stage	Collectively Stage	Formalization and Control Stage	Elaboration of Structure Stage
Marshalling of resources	Information communication and structure	Formalization of rules	Elaboration of structure
Lots of ideas	Sense of collectivity	Stable structure	Decentralization
Entrepreneurial activities	Sense of collectivity	Emphasis on efficiency and maintenance	Domain expansion
Little planning and coordination	Long hours spent	Conservatism	Adaptation
Formation of a "niche"	Sense of mission	Institutional procedures	Renewal
Prime mover has power	Innovation continues		
	High commitment		

Table 1: The Organizational Life Cycle

Source: Cameron, K. S. , and Whetten, D. A. 1983. Models of organizational life cycle: Application to higher education. *Rev. Higher Educ*. 6(4): 269-299.

Many firms, especially smaller enterprises, never reach the later stages in the organizational life cycle, either because they disappear or because they don't reach a size that requires much formalization. Nevertheless, the importance of the distinction between formal and informal social networks grows as structures become more complex.

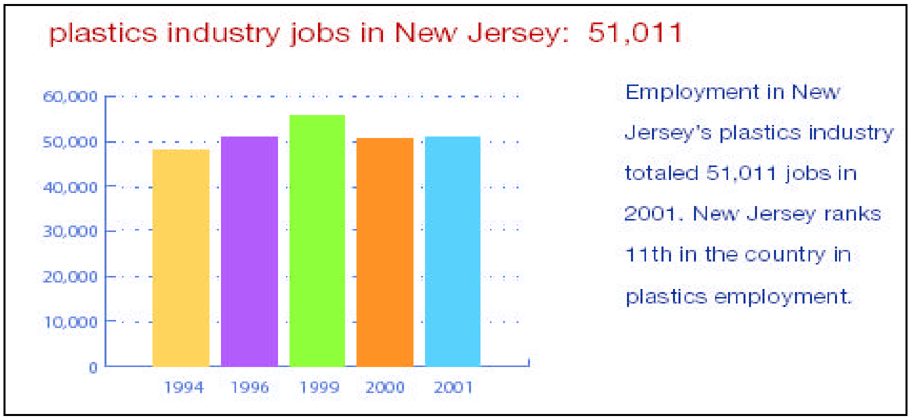
<u>Industry Background</u>

The industry sector studied in this project is plastics products. It was chosen because the technology is relatively simple, it has eco-efficiency and pollution reduction opportunities, there are many small and medium-sized firms available as case study candidates, and it is undergoing a dramatic transformation due to competitive pressures from economic globalization.

Plastics Product Manufacturing

The two basic groups of plastic materials are the thermoplastics and the thermosets. Thermoplastic resins consist of long molecules, each of which may have side chains or groups that are not attached to other molecules, so they are not cross linked (SPI, 1999a). Thus, they can be repeatedly melted and solidified by heating and cooling so that any scrap generated in processing can be reused. No chemical change generally takes place during forming. Usually, thermoplastic polymers are supplied in the form of pellets, which often contain additives to enhance processing or to provide necessary characteristics in the finished product (e.g., color, conductivity). The temperature service range of thermoplastics is limited by their loss of physical strength and eventual melting at elevated temperatures.

Thermoset plastics, on the other hand, react during processing to form cross-linked structures that cannot be remelted and reprocessed. Thermoset scrap must be either discarded or used as low-cost filler in other products. In some cases, it may be pyrolyzed to recover inorganic fillers such as glass reinforcements, which can be reused. Thermosets may be supplied in liquid form or as a partially polymerized solid molding powder. In their uncured condition, they can be formed to the finished product shape with or without pressure and polymerized by using chemicals or heat.



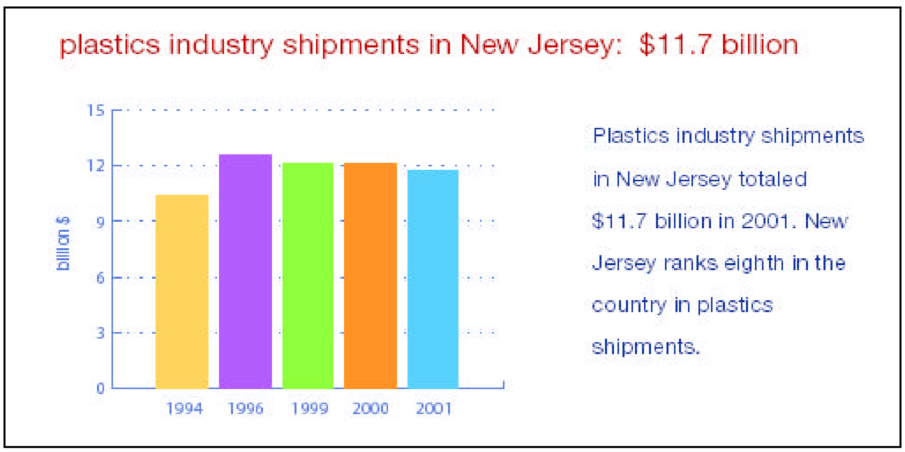


Figure 1: New Jersey Plastics Industry Employments and Shipments
Source: SPI (2002)

New Jersey is one of the top ten states accounting collectively for 60% of the total U.S. plastics industry shipments (SPI, 2002). Unofficial statistics suggest that both employment and shipments have dramatically declined in this industry since 2001.

Plastic Injection Molding Industry

Injection molding is the principal method of forming thermoplastic materials. The production process is organized around runs of product (e.g., an order for 100,000 plastic coffee cup lids). Large volume runs of simple items (like coffee cup lids) have low profit margins because there are too many competitors for this type of simple product. On the other hand, the most profitable firms deliver high quality, complex, molded products often in smaller runs (e.g., an order for 1000 laptop computer housings). Generally, the injection molding business has a range of production specialties. At the smaller end, the precision molders make very small parts and at the large end they can make larger, more complex parts (e.g., automotive parts). There are two types of injection molders:

- Custom, contract molders make parts specific to the needs of their customers
- Proprietary, captive operations make their own products

The relevant NAICS codes that apply to this industry include:

NAICS Code	Description
326199	All Other Plastics Product Manufacturing
325991 & 3261	Plastics Product Manufacturing
32613	Laminated Plastics Plate, Sheet, and Shape Manufacturing,
32614	Polystyrene Foam Product Manufacturing
3087	Custom Compounding of Purchased Plastics Resins
325991	Custom Compounding of Purchased Resin

Technology & Innovation

Injection molding is a branch of the plastics industry that involves injection under pressure of molten plastic into the cavity of a mold followed by cooling and removal of the solidified part that retains a replica of the mold. The injection molding industry is arguably in its infancy. It was only during the 1960s that reciprocating screw technology became commercially viable. With the advent of the microprocessor, there have been significant advances in process control during the 1980s and 1990s. There have been equally significant advances in screw technology, multi-color molding, insert molding, gas assisted injection molding, and other niche processes. There have also been major advances in polymer materials, mold making, and of course, predictive analysis tools for avoiding problems before they occur and optimizing every phase of the design-to-manufacturing process.

However, in spite of all these advances, the injection molding industry continues to exhibit signs that it is still a very young industry. For example, it remains common to set up and optimize the process using time-consuming and inefficient trial-and-error methods. While molders may be able to obtain acceptable quality parts using this method, the process usually requires constant fine-tuning to maintain quality parts because it was not set up using a rigorous scientific quality control method. Failure to setup and optimize using a rigorous method normally results in a process that is not robust and therefore, is difficult to control. Beyond the setup, optimization, and control of the process, there are additional injection-molding manufacturing tasks that must be performed, optimized, standardized, and integrated across the company-wide enterprise. These additional tasks include, but are not limited to, production scheduling, preventive maintenance, process and production monitoring, statistical process control, statistical quality control, and production reporting. It is also becoming increasingly common for an injection molder's customers to demand value-added operations such as part traceability, while simultaneously demanding per-part price decreases. Facing these challenges, injection molders must not only implement systems and processes to achieve the value-added demands, but also accomplish them cost-effectively while improving the efficiency of their existing operations.

Employee Tasks

Injection molders typically work in small independent firms with relatively few employees (5-100). Most of the employees are semiskilled workers who load plastic pellets into the injection molding machines, mixing in some recycled plastic waste as available. Once the plastic has cooled and re-solidified the mold opens and the plastic product is removed. If the machine's temperature is set too high, air pollution can result in the form of fugitive volatile organic releases. In a typical machine, every 30 seconds the machine completes a cycle, dumping a cooled molded plastic piece onto the factory floor. Injection molding machines require thorough maintenance, otherwise they become unreliable. Workers take the molded plastic pieces and break off the extra bits of plastic (little nubs and frames). The amount of plastic waste is a function of the mold design and the amount of product made.

Workers then put the waste plastic into a grinder and store it for use as recycled feedstock. Recyclability is a function of the type of plastic material used (some plastics can't be recycled once heated). Un-recyclable plastic is disposed of offsite. Workers inspect the product and reject some pieces (these get recycled) and pack the product into boxes for shipping. These boxes are shipped to customers according to a supply schedule. A process engineer supervises multiple injection molding machine lines and orders raw materials. A marketing manager solicits orders for products and a plant manager coordinates the marketing and production activities, settles employee disputes, and seeks to maintain profitability.

Industry Outlook

The injection molding business's golden era spanned the1970s - 80s when there was less competition at the machine and process level and firms produced very high profit margins. Now there are abundant machinery manufacturers and processors inundating the market. Processors range from small family operations with a handful of machines to larger companies with hundreds of machines. Other dynamics are also lowering the margins, including increased competition from Asian imports. Asian markets have very low costs, particularly labor costs, relative to U.S. operations.

Plastics Injection Molding Process

In injection molding, plastic material is put into a hopper that feeds into a heated injection unit. A reciprocating screw pushes the plastic through this long heating chamber, where the material is softened to a fluid state. At the end of this chamber there is a nozzle that abuts firmly against an opening into a cool, closed mold. The fluid plastic is forced at high pressure through this nozzle into the cold mold. A system of clamps hold the mold halves shut. As soon as the plastic cools to a solid state, the mold opens and the finished plastic is ejected from the press SPI, 1999b).

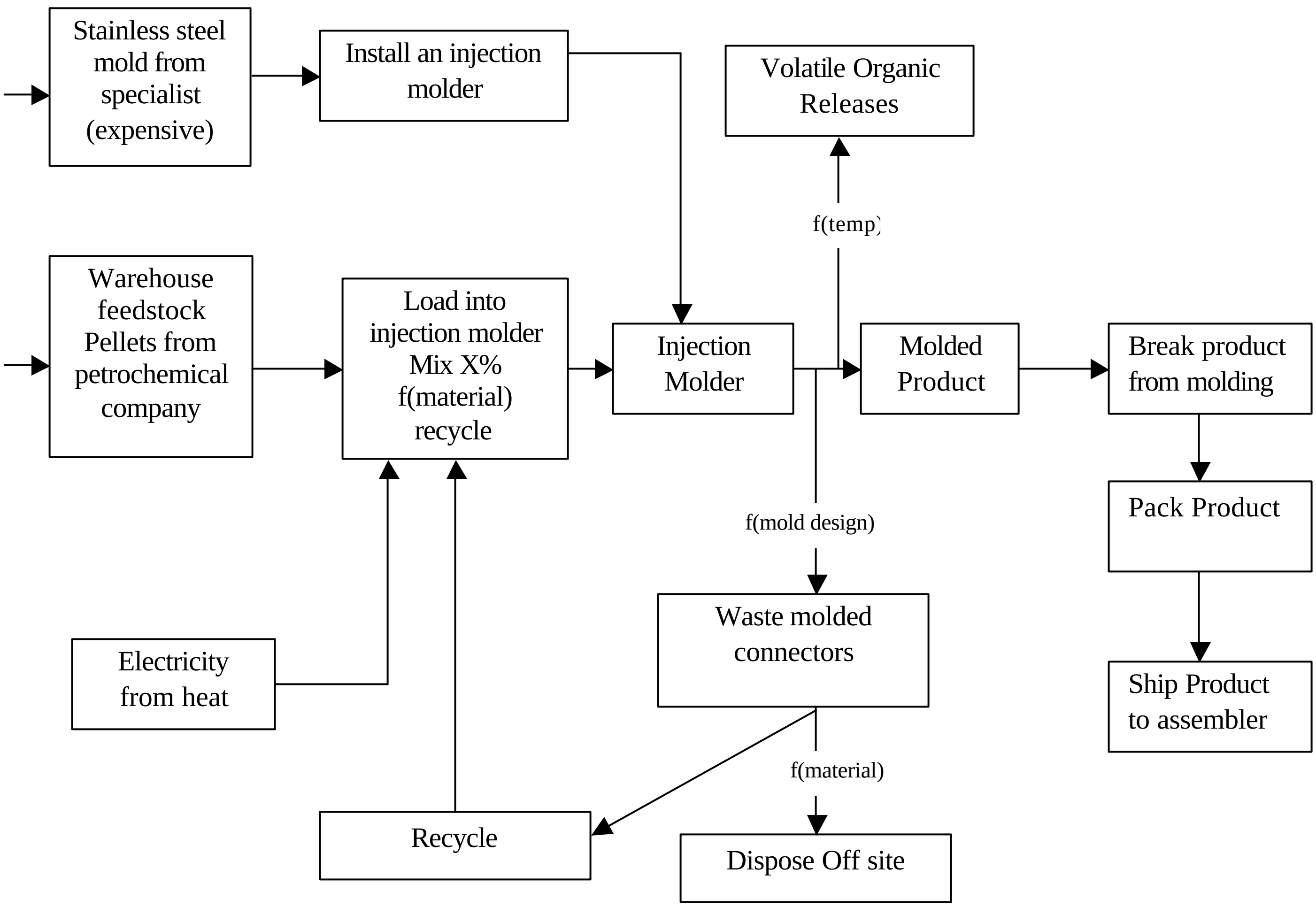


Figure 2: Plastics Injection Molding Process Diagram

Methods

Three plastics injection-molding firms in New Jersey and one multinational chemical corporation were selected for study. The three plastics firms were selected because they were accessible and because they have relatively simple manufacturing processes that could be more easily modeled. The multinational chemical company was studied less formally, specifically for their approach to environmental management. The case studies of the three companies include in depth interviews with the presidents or owners of each firm, analysis of business, financial and environmental records, and site tours of the manufacturing floor. Each interviewee reviewed and signed an informed consent form and their names and the names of their companies remain confidential.

Firm	Description
Company 1	Plastics, Injection molding, Single establishment, family run
Company 2	Plastics, Injection molding, Single establishment, family run
Company 3	Plastics, Injection molding and extrusion, Subsidiary of Multinational company
Company 4	Multinational chemical firm

<u>Case Study Findings</u>

In depth interviews with the presidents or managers of the three injection molding companies revealed a great deal of information regarding the importance of: formal and informal networks in workplace practices such as innovation and safety measures, the role of a family run vs. a corporate culture environment, external market dynamics, stable workforce dynamics. The following hypotheses reveal a rich picture of this particular industry and also highlight some important lessons more generally, regarding organizational behavior's ties to workplace practices.

Hypothesis 1a: *As the external environment becomes increasingly competitive, the family-run businesses decrease the social amenities available to employees.* ***Supported.***
Hypothesis 1b: *As family run businesses experience a generational shift, the social practices of the company also shift.* ***Supported.***

Interviews with all three companies revealed that there has been a shift in the business culture towards a less social work place indicated by the decrease or elimination of company sponsored social activities such as company sports teams or company picnics. In the case of the first two companies, which are run by a second generation of family members, this shift to less social activities also coincides with a shift towards a more competitive market environment and less profitability. Interestingly, the third company which operates under a more corporate culture (subsidiary of multinational company) and is not run by family members, offered many more social amenities to their employees than the first two family run companies. This difference may mean that the decrease in social activities in the first two companies may be primarily due to scarcity of resources to support such activities. On the other hand, the quality, scope and relevance of the social activities in place at Company 3 cannot be measured by this case study and therefore it is difficult to compare and contrast the activities of one company with past activities of the others. The generational shift evident in the two family-run companies was also accompanied by a downturn in the economy and increased competition in the industry. Were these social activities cut because the second generation was not as socially tied to the employees or had a different relationship with employees than their predecessors? Or is this decline a direct outcome of scarce resources to dedicate to social amenities?

According to Company 1's President, the decline of company sponsored social events might be attributable to both a generational shift and a resource allocation issue. The current owner feels that if his father were still running the business that many of the social activities he sponsored would probably still be in place. This is because part of his father's "style" was that he felt more comfortable interacting with the employees through these types of activities as opposed to more informal contact on a daily basis. The current owner thinks it was partly due to his age that he didn't relate as easily with the employees so that the social activities were a mechanism for reaching them. The owner today and his brother take a much more relaxed approach in which they feel comfortable with their employees and interact with them on a daily basis in a less structured way on the factory floor. In this case, the social activities would be nice but they are not really necessary for them to get to know the employees. On the other hand, if the current economic situation allowed for more profitability with a surplus of money available, a situation more similar to when their father ran the business, then they might well consider offering more social activities. In many ways the decision to offer company-sponsored social activities is product both of resources and personal style.

At Company 2 on the other hand, the original owners, the fathers, were very "hands on" interacting mostly on the factory floor as technical tool-makers, they were very close to the factory workers. The second generation in this company was less "hands on" and more focused on the business aspects of the company. At company 2, the owners attribute the decline in social activities more to a lack of resources and the sense that employees were not participating in the activities. In the past the company hosted several company sponsored social activities such as picnics that have since faded when they moved to a new facility a few years before, "*We used to have picnics, a company picnic. The last one was before we moved over here, but we stopped them because our business had fallen and the money wasn't really there for that or we didn't want to use it for that. I think there was also some distaste on our part that we didn't feel our employees were participating at that point*."

Company 3 offered a wide range of social activities including a bowling team, company luncheons, educational training, and other activities. Company 3's manager sees a great deal of value in sponsoring these events. The manager states, "*I would say that happens [interaction between positions] in the sports driven activities like bowling. It gets the full gamut of employees. You get staff management out there bowling and the maintenance folks and set up operators and packers, one big team*." This type of socialization is also seen as a positive contributor to company morale on the factory floor. The general manager describes the effects of such social activities on the company as follows, "*It helps on the factory floor. I don't know if I can quite put my finger on it, but when you have a crew that's been around, that's as senior as the one I've got, there's a wonderful camaraderie but there's also a totem pole*."

Hypothesis 2: *Family run businesses have strong social ties to employees, and thus may be less likely to streamline and cut labor. This theory is based on the human relations theory of organizational behavior.* ***Not supported.***

This dynamic works well for explaining promotional or recruitment/ hiring practices but is not the driving factor in the business. Company 1, for example, relies on informal communication networks and close ties/familiarity with employees to determine promotions and even hiring or firing decisions. But Company 1's president also emphasized the need to continuously streamline and cut low skilled positions by automating these jobs, thereby reducing high labor costs allowing them to stay competitive in the marketplace. Company 2 actually detailed the difference in approach to employees with the increased competitive market, *"The biggest difference between business today and 15 years ago is that you can't stand still. Fifteen years ago you could stand still and just make product and move things along, add an extra employee here or there. If they weren't contributing too much we just let it go. Today it's to the point where you can't afford any of it. And it's hard to get business because there's so much competition."* The second generation of owners has to consider this increased competition when making decisions about the labor force. Company 3 on the other hand, while not a family-run business, emphasizes the importance of family members working together in the company, *"It makes us a small, entrepreneurial, family run business with a push of a big organization behind us. It makes us human. Christmas parties are more fun. We don't have kids working here but we have had families over the years, a husband and wife, a 45-year employee with her son who's been here 25 years. So yes, we have families."* Increased competition in the business is driving the streamlining of the workforce, and this raw economic factor outweighs most personal connections to workers. However, this case study was unable to document the exact pattern of hiring and firing practices conducted by each firm and had to rely on management's account.

Hypothesis 3*: Informal communication networks will be important for a variety of business management aspects for family run businesses.* ***Supported.***
Informal networks seem to be important for how the family firms in particular (Company 1 and 2) handle issues such as: environmental and safety procedures, supplier and customer relations, promotional, hiring and recruitment practices (and termination). Informal Networks are important for recruitment, hiring, and promotional practices inside all three firms. Recruitment practices in Company 1 and 2 are also based on more informal networks or "word of mouth" from current employees. This informal mechanism of bringing in new employees is another reason why many family members work together on the factory floor. By hiring in this manner, existing external social networks are transplanted into the workplace. Seniority and tenure in the workforce matters more, in terms of stored knowledge and experience in the workplace, than formal credentials. This reliance on experiential knowledge is evidenced by the promotional practices in all three companies where promotion to higher skill levels occur from within the company as opposed to bringing in new experts from the outside. For termination, Company 3 relies on a more formal process involving the corporate human resources department, while the first two companies rely more on informal processes for reviewing individual employee behavior and performance both for promotional and termination consideration.

Companies 1 and 2 describe an incremental approach to innovation in which they try a new idea for a little while and then determine whether it is viable to go on before making a large investment in a new product or process. This type of innovation also relies on informal information networks like trade journals and trade shows, relationships with machine manufacturers and customers and relationships with senior employees that are familiar enough with the business to develop new ideas. In Company 1 and 2, the owners were directly involved in the innovation process with no formal R&D staff in place. Company 3 on the other hand relied on corporate R&D support services for larger scale innovations in the production process. But Company 3 still developed many of its practical innovations on the factory floor with help from long term employees.

Company 3 seemed to rely on factory floor employees to improve safety measures in particular. The company set up a subcommittee and a suggestion box on the floor to encourage employees to bring their interests and innovation to bear on the issue of workplace safety. The manager of Company 3 emphasized the possible importance of employees' previous experiences or knowledge outside the firm to bring innovations and improvements to safety procedures in the workplace. The manager perceived this input from employees as a driving factor in the improvement of their safety record. Informal networks also seem to be important mechanisms for financing for the two family run businesses, Company 1 and 2. These two companies rely on long term banking relationships as their main source of financing and this relationship is based on trust in the reputation of the firm. The corporate firm, Company 3, relies on more formal mechanisms for financing through their corporate structure. Within this structure, Company 3 had to follow a formal process for justifying any new financing.

Formal networks are important for a variety of functions in all three companies although it is more prominent in Company 3. Company 3 is tied to a corporate parent that imposes a more formal structure on the firm than is evident in the first two single establishment firms. All three companies comply with federal and state environmental (EPA), Safety (OSHA) and labor standards. All three also seem to pursue environmental (recycling waste) and safety improvements according to an eco-efficiency principle in which the improvements are done independent of economic activity but the impact of the improvements are felt both in economic and environment and safety measures. While all three companies are compliant with some type of trade standards, Companies 1 and 2 are moving towards increased compliance with newer industry standards like ISO 9001 and 14001. Company 3 seems to have many of these certifications in place already, which again may be a reflection of more stringent corporate standards and more available resources to come up to compliance. All three companies describe the impacts of increased supply chain management schemes which put pressure on them to take on more of the risk. The three companies also have a flat organizational structure with manufacturing jobs representing the bulk of the employee base at the bottom of the hierarchy.

Hypothesis 4*: There will be high turnover in laborers because of low skill, low wage nature of work.* ***Not supported.***
The low level employees in the company are generally low wage earners with pay ranging from $6.25/hour to $8.50/hour. While this wage seems relatively low, compared with other low skill level jobs in the service sector, these manufacturing jobs represent

better opportunities because of the accompanying benefits packages. Despite the low wages and the repetitive nature of the work, all three companies describe an extremely stable workforce with low turnover in all levels of workers. This low turnover may also be due in part to the opportunities for promotion within the company. The owner of Company 1 stated, "Everyone in our supervisory positions have been promoted from below, but she [an employee we met on the floor] was the first one to cross the picket line, so we have a special affection for her." Company 2's described promotions from lower levels, "There's a lot of that particularly with us. I think most molders are probably like that. You've got somebody who started second shift to stand by a machine, he shows a little bit of mechanical skill and interest in the job and we say well let's try him out here. If it works out well, it keeps on going. Right now our customer manager, which is probably one of the most important things we do here, he started out as an assistant foreman on second shift. He's a young guy who's going to school, he spoke good English which is important, showed a lot of energy and a lot of interest and moved up to assistant supervisor..." The manager for Company 3 also states, "We seek to grow people within the organization…we have various folks in our business who started in the plant."

Each interviewee recounted "success" stories of employees who started out in a very low level position like operator or packer and how they worked their way up the hierarchy through promotions due to good work habits, positive attitude and interest in moving up. The firms seem to reward good worker traits and reinforce this through internal promotions. The firms also did not put much emphasis on high levels of education or schooling but emphasized more the importance of experience and reliability. The Hispanic low-level workers are newer to the firms and are working their way up through the ranks. In Company 1 for example, the recent promotion of a Hispanic worker into a supervisory position is seen as a positive impact on lower level workers' morale because they feel closer to the upper ranks and they can aspire to also be promoted. This same worker was promoted because the owners of the company admired her loyalty to the company during a union strike when she crossed the picket line first. This illustrates how promotions are based on more than just efficiency or lines of command within the organization.

The interviewees described some overarching traits that are desirable for hourly, low skilled workers which include; manual dexterity and proficiency on the machines, reliability in attendance, quality of products and functions, willingness or interest to learn business, loyalty. For salaried or higher skilled workers, interviewees emphasized the level of commitment and interest in the business, accountability, reliability and positive attitude in the workplace. Free rider or shirking problems in the industries arose in one example from Company 2 when the interviewees described problems of accountability with employees. The company does not look favorably on employees who shirk responsibility for problems or mistakes on the factory floor. This shows that where there is a lack of accountability, shirking will occur and the human resources process weeds out people who tend to be unaccountable.

Outlook on the Injection Molding Industry

Company 3's business prospects for the future seem to be more secure than Company 1 and 2 due to their relationship with a larger parent corporation which provides them with greater flexibility, mobility and resources than the small family run companies. While Company 3 is small in terms of the number of employees at the facility, they can afford to be leaner (in terms of employees) because of the additional resources provided by the parent company. The drive of the plastics industry towards Asia seems to be easily accommodated by the parent company's relationship with other business units located in Asia. Both Company 1 and 2 experienced both a generational shift and a large market shift in their businesses in recent time. The plastics industry became increasingly competitive in the late 1990s while their fathers were transitioning the companies into the hands of their sons. This dual shift may account for a transition in both the business strategies employed by the firms to remain profitable and the social dynamics of the employee base. Traditionally, these family-run companies relied on long term, low skilled factory floor employees and repeat customers with little marketing or research and development efforts. Today, all three companies face increased competition from Asian companies that offer the same products but have much lower labor costs than US firms. This shift in the market has forced US firms to streamline their labor force and become increasingly automated to increase efficiency and reduce labor costs. The companies are also forced to find competitive advantages in their product marketing and innovation.

Company 1 in contrast to Company 2 is more optimistic about its future prospects in the business. This optimism is primarily due to Company 1's multifaceted strategy for surviving in the increasingly competitive market through streamlining, increased automation to reduce labor costs, horizontal integration via the acquisition of smaller operations and cornering a niche market in fire safety equipment along with a large multinational company contract. Company 2 has increasingly automated but is struggling to market their business and tap into new customer bases that they can keep long term. Company 3 is perhaps the most economically stable due to its connections to business units worldwide and their corporate resources.

One indicator for the strength of social networks in each company can be seen in the company sponsored social activities. Company 1 and 2 both experienced a decrease in the number of activities sponsored by the company at the same time that the dual generational and market shifts occurred. Interestingly, Company 3 seems to offer many more company sponsored social activities than the family run companies - suggesting that it's not just the familial nature of the company but rather the financial stability of the firm that matters a great deal in terms of supporting such social activities. Despite the drive towards automation, all three companies rely on a stable workforce characterized by low turnover and long term employees. The importance of these long-term employees in the workplace is reflected in the "totem pole" hierarchy or informal hierarchy that is established within the rank file between long term employees and new hires. According to this totem pole, long-term employees' rank overrides any professional credentials a newcomer brings to the workplace.

The entry-level employees in all three companies are comprised of mostly Hispanic and other non-English speaking people. The similar ethnic background of the entry-level employees and the internal promotion practices creates a very close knit employee base which may also have many connections outside the workplace. It is difficult to characterize the nature or extent of these social networks because this study did not interview or study these employees directly. Company 3's manager emphasized the importance of personal and social networks in improving the safety on the factory floor in particular. Social networks, social activities outside work and the presence of family members working on the floor were perceived as a benefit to the company in terms of improvements in safety along with more general improvement in morale and productivity. But unlike the other two companies, Company 3 did not have family members running the operation, only working as lower level employees.

The competition from China is putting increased pressure on all the firms to cut back low skilled operators. At the same time, the owners seem to value company loyalty as evidenced in their respect and admiration for long-term employees. It will be interesting to see how these two forces – increased drive to streamline the workforce and a close connection with the employee base will evolve over time.

Model-building activity

Researchers can productively induct theory from case studies that, like good computer programs, offer parsimony and logical coherence (Eisenhardt, 1989). This begs a question: why not express theory in the form of a computer program? Parsimony was a goal of the modeling effort, and logical coherence was a handy byproduct of the debugging process. The dual challenges with any type of modeling are to simplify reality appropriately and to communicate the results effectively (Andrews, 2002). Both challenges proved significant during the modeling process.

Multi-agent simulation

Object-oriented programming languages like Java make it possible to specify and replicate software agents relatively easily. These agents can be purposive and autonomous, and they can interact with one another and with an external environment. Multi-agent simulation modeling, so called, is an intellectual descendent of game theory, artificial life, and cellular automata, and it is gaining wide use as a social science research method (Epstein and Axtell, 1996). There is already some experience with applications to organizational behavior research (Carley and Prietula, 1998) and industrial ecology (Axtell et al, 2002).

Using the Brookings Institution's Ascape multi-agent simulation framework (Parker, 20000), a Java programmer created PolyModel, a simulation of operations at a plastic injection-molding firm. Approximately 100 employees interacted with the production technology and one another, subject to changes in the firm's external environment. The model included technology details, organizational structures, and parameter values taken from Company 1 in the case study. The model tested alternative theoretical constructs explaining the behavior of employees, to be roughly validated against the evidence from case study Companies 2 and 3.

The current model includes 22 classes of agents, related as follows.
PolyModel contains People, the Factory, and the External Environment.
The Factory includes a Warehouse, Production Lines, and a Shipping Department.
Employee extends Person.
Owner, Plant Manager, Marketer, Engineer, Shift Supervisor, Shipping Clerk, Materials Mixer, Maintenance Technician, Machine Operator, and Janitor all extend Job. Each Employee has a Job.
Remaining Java classes serve as computational infrastructure.

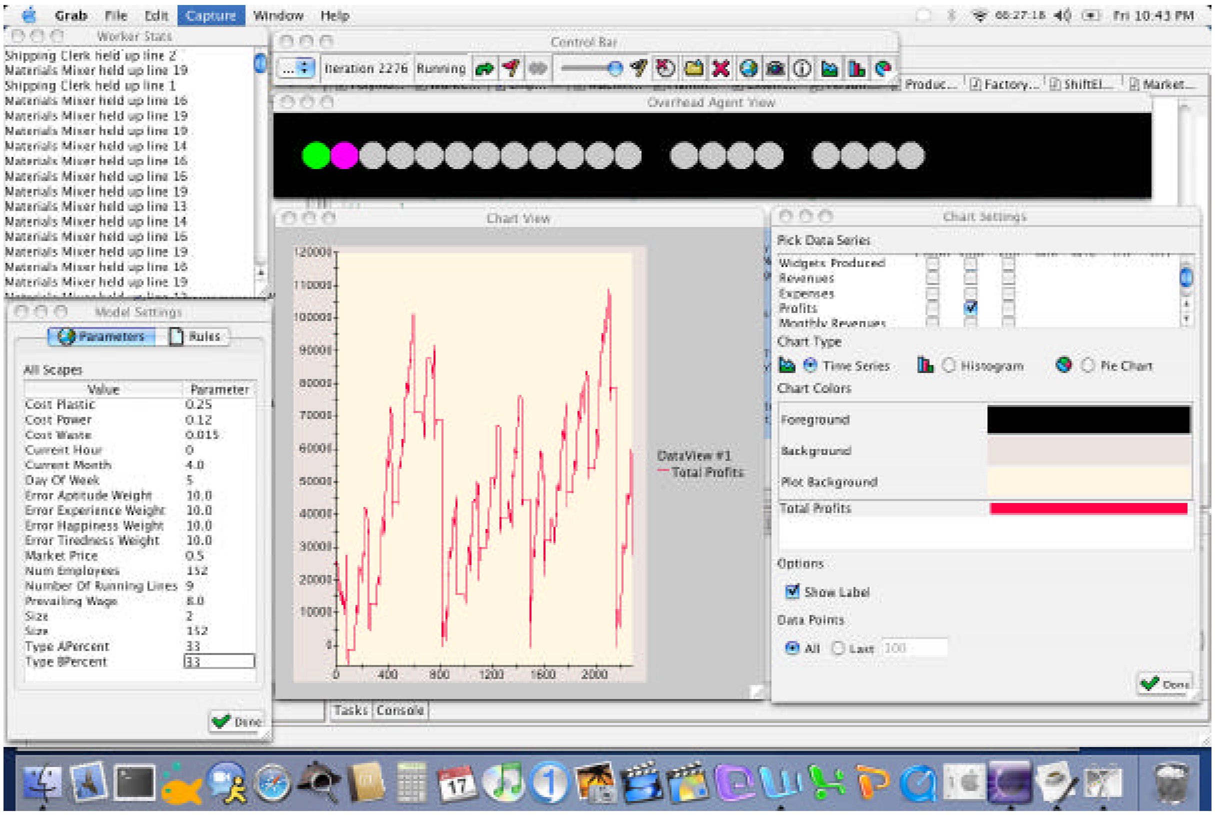
The time step in the model is hourly, so the firm cycles through the workday and the work week over a period of years. Each employee assesses whether to go to work every morning, based on health, social pressures, and finances. The plant manager determines how many production lines and associated employees are needed based on pending orders for widgets. The marketer brings in orders and tries to keep ahead of production so that the capacity factor of the plant is high. The janitor keeps the factory clean, and other employees become unhappy if the factory gets dirty. The materials mixer ensures that raw materials reach the production lines, and the shipping clerk packages completed products and sends them out the door. The maintenance technician keeps the production lines in working order. The machine operators perform several sequential duties (load plastic pellets, set molder temperature, separate widgets from scrap plastic). The shift supervisor encourages machine operators to work more carefully and reports on employee performance to the plant manager. All employees are subject to worker error that affects the quality of their performance, and the probability that error will occur is a function of aptitude, experience, tiredness, and happiness.

```
       }

       public double getWorkerError(){
              double aptFactor = ExternalEnvironment.getAptitudeWeight() * (100-
this.getAptitude()) / 100;
              double expFactor = ExternalEnvironment.getExperienceWeight() *
(65-this.getDaysWorking()/250)/65;
              double hapFactor = ExternalEnvironment.getHappinessWeight() *
(100-this.getHappiness())/100;
              double tirFactor = ExternalEnvironment.getTirednessWeight() *
this.getTiredness()/100;
              return aptFactor + expFactor + hapFactor + tirFactor;
       }
```

Happiness is a weighted additive function of wealth and social embeddedness. MoneyGrubbers like wealth (90, 10), SocialAnimals like their friends (10/90), and TheRestofUs are more balanced (50, 50). Wealth increases by getting paid at work, social embeddedness increases by making more friends at work and elsewhere. Friendship depends on affinity (similar intrinsic characteristics) and frequency of interaction.

As the screenshot below shows, the dynamics of these employee interactions provide realistic drama and aggregate up to firm-level performance measures of interest to management. Parameters are adjustable on the fly, and various diagnostic tools allow the user to investigate the causes of particular dynamic behaviors.

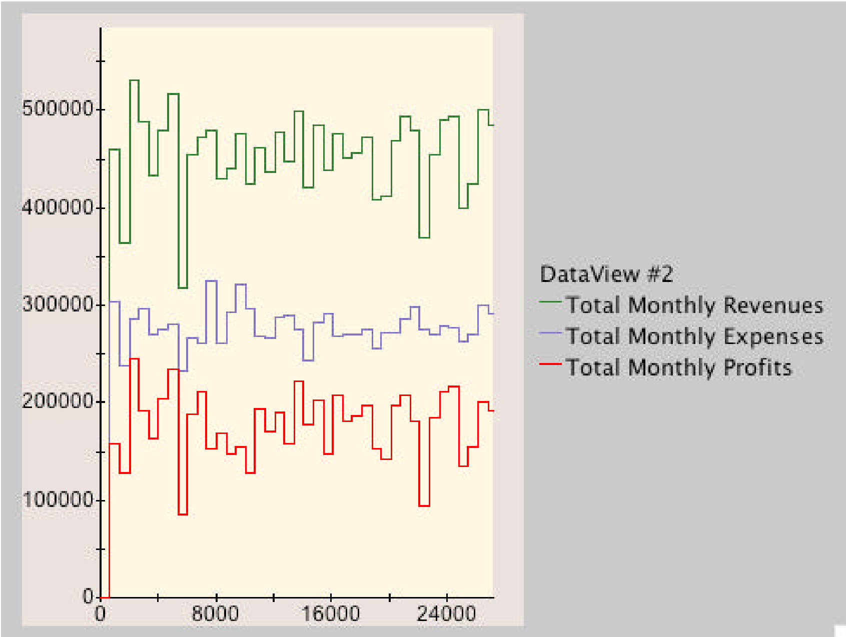


Developing the model required intense interaction between the programmer and the qualitative researchers. Much conversation centered on eliciting precisely what was the theory being formalized in the model. As the researchers played with the resulting simulations, the theoretical framework evolved.

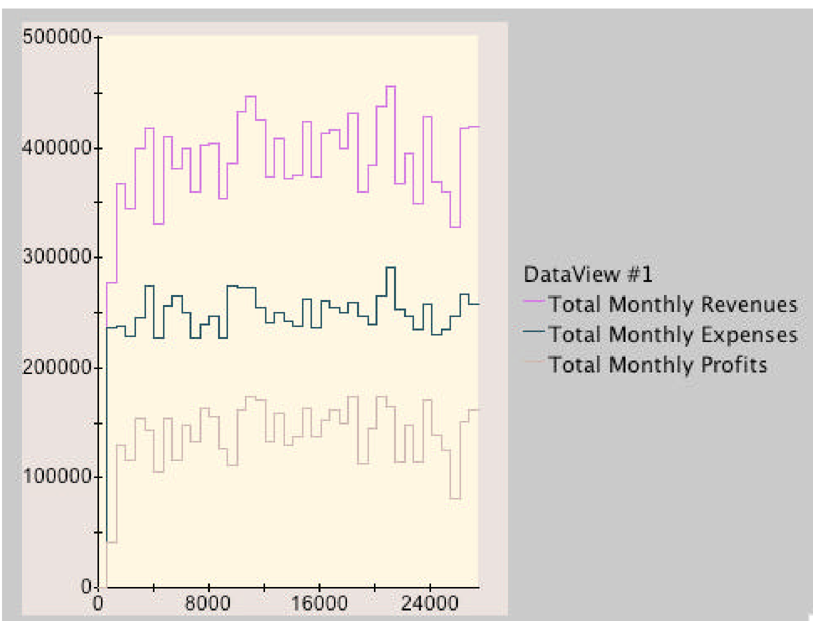
Illustrative Result—Bringing in Worker Error

This paper briefly shows one illustrative result. The project is ongoing and the model, underlying theories, and empirical evidence continue evolving. The model may eventually become robust enough to serve as a management-training simulator for the plastic injection molding industry.

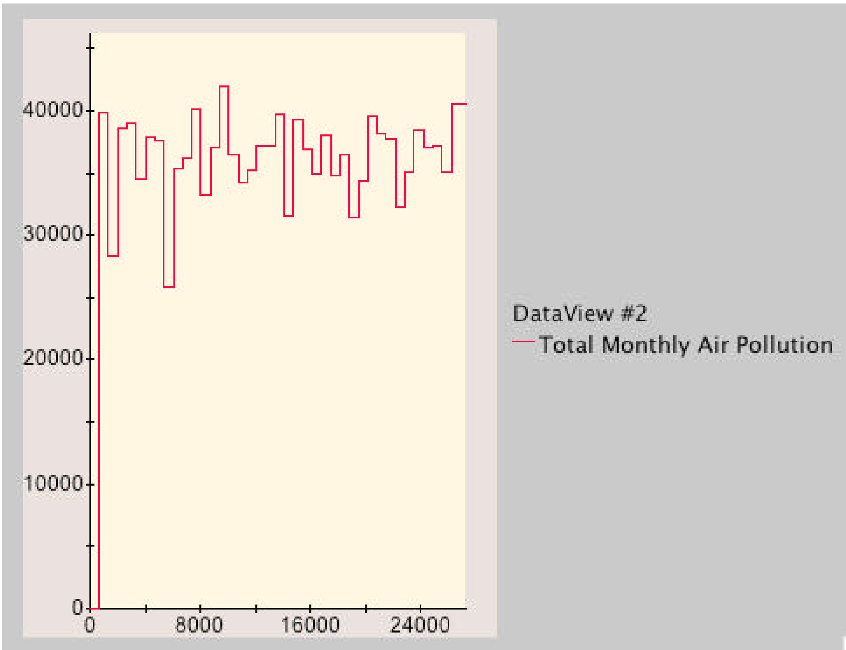
The frictionless neoclassical model of the firm typically assumes that every employee behaves like *homo economicus*, a rational, omniscient, selfish maximizer. Only principal-agent problems detract from corporate performance in that model. Our model allows us to turn worker error on and off, and thereby compare results under contrasting assumptions regarding that element of bounded rationality. As the following graphs show, a firm having imperfect (aka realistic) employees is less profitable and pollutes more. Policies to reduce worker error can now be tested *in silico*. More detailed theorizing about the determinants of worker error also becomes possible.



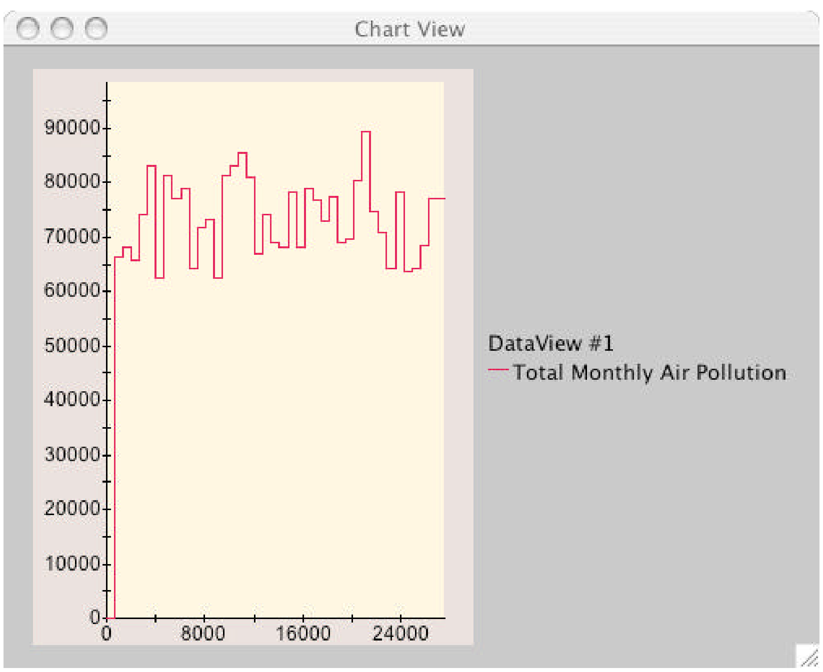
Homo economicus: Profits without worker error



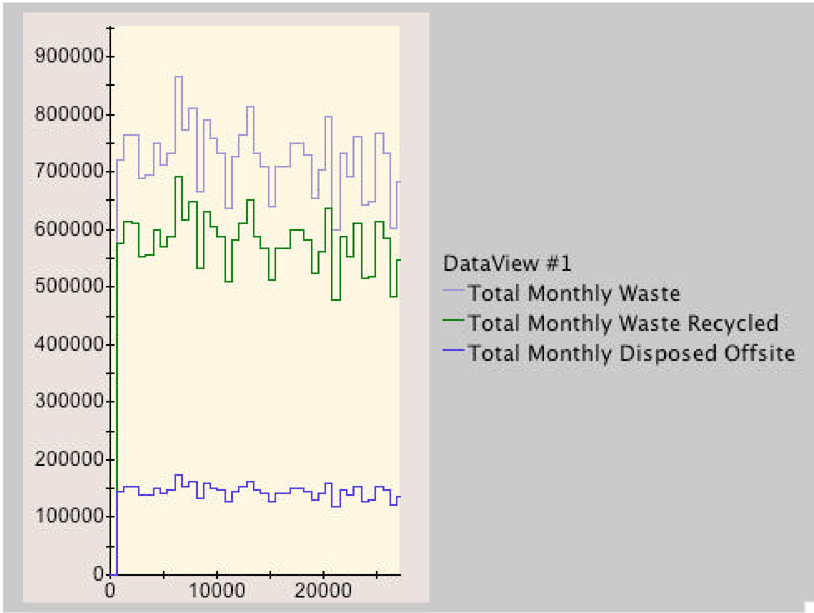
Realistic employee: Profits with worker error



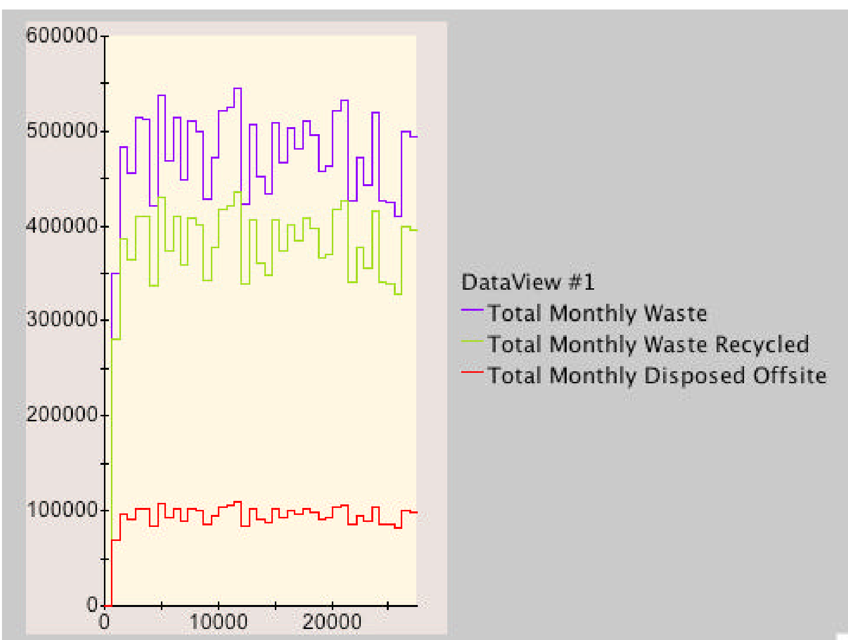
Homo economicus: Air pollution without worker error



Realistic employee: Air pollution with worker error



Theorizing worker error #1: Error = f(experience)



Theorizing worker error #2: Error = f(experience, aptitude, happiness, tiredness)

Conclusions

Theory building

Regarding the motivating question for this research—what are the relative roles of informal social networks and formal regulatory structures?—the modeling and case study evidence support three insights to date. First, informal networks are very important for hiring new employees and for helping employees to decide to take job actions like strikes and sick day protests. Second, formal structures are hugely important for explaining almost everything else. In this industry there also appears to be a substantial amount of technological determinism. In other words, the type and economics of the technology explain much of the firm's overall behavior.

Lessons learned

There are two major lessons learned for researchers interested in using multi-agent simulation models and case studies in a grounded theory-building context. First, this project shows that highly diverse skill sets are needed. In fact, it is unlikely that a single individual will have the requisite range of skills, necessitating recruitment of a multidisciplinary team consisting of an interviewer, case study developer, and Java programmer. Second, iterative modeling and interviewing is crucial because new questions arise, and alternative theories need to be explored and elaborated.

The benefit of developing multi-agent simulations in this inductive way is that they appear to inform action more directly than a deductively-based model built from principles rather than evidence might. It becomes a humbler but perhaps more valuable type of social science.

Case studies are informative but static research products. By taking the next step and constructing a simulation model, this research becomes more dynamic and iterative. It becomes easier to communicate theoretical expectations and to revise them. It potentially can help with *in silico* management training and strategy development so that fewer costly mistakes get made by firms and their regulators.

Future work

There are many valuable extensions of this work that deserve future attention. First, the establishment-level model should be extended to the case of the branch plant with a corporate parent. Then the modeling effort should expand vertically to include the supply chain, and horizontally to include sectoral competitors. It would also be interesting to adapt this modeling approach to industrial clusters and eco-industrial park tenants. In addition, much more needs to be done to explore the potential for socially responsible behavior to affect overall corporate performance. Other extensions suggested by the case studies include further investigation of the special characteristics of family owned companies, and of the value and measurement of employee loyalty.

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Do Facilities With Distant Headquarters Pollute More?: How civic Engagement Conditions the Environmental Performance of Absentee Managed Plants

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Social scientists have long speculated that factories with distant headquarters are a threat to communities and their physical environments. Over fifty years ago, when “war plants” were being created outside the nation’s industrial heartland, several researchers warned that absentee managed plants are the “puppets of big business” and will exploit the social and natural resources of their host communities. Today, as the winds of globalization and capital flight disperse still more facilities across the landscape, researchers continue to express concerns about the local impact of absentee managed plants. They worry that due to advances in transportation and communication technologies, more corporations than ever before will be able to externalize their pollution by setting up plants in far-flung, less regulated areas.

However, scholars have not analyzed the environmental performance of absentee managed plants. Nor have they explored how their tendency to pollute varies by the types of communities that harbor them. To begin to remedy this situation, I examine how the emissions of absentee managed plants are conditioned by their host communities.

This topic is an especially important one. Precisely because more companies can manage operations from afar, absentee managed plants are rapidly becoming the modal type of industrial organization. Hence, if they are an environmental threat, as some suggest, then a type of organizational virus is spreading throughout the eco-system that demands analysis. There is also a strong perception within the anti-globalization movement today that absentee managed plants pollute more than locally managed ones. Critics of globalization assume further, like Mills, that there is little communities themselves can do about this problem because their survival depends on attracting and accommodating footloose plants.

I contend that critics' logic is simplistic and overlooks the potential impact of local civic engagement on pollution outcomes. First, to suggest that communities are powerless to "outside predators" ignores how responsibility for protecting the environment from globalization and other forces has gradually devolved from the nation-state to the local level. A prime example of this development in the U.S. is the Emergency Planning and Community Right-to-Know Act. This act seeks to curb industrial pollution by requiring manufacturers to submit data on the toxins they emit. It also makes states responsible for developing right-to-know programs that disseminate this information to their citizens. The rationale behind this decentralized strategy is that manufacturers are more apt to voluntarily reduce their future emissions when confronted by an active and well-informed group of local citizens.

Critics also ignore recent studies on civil society that speak to the ability of communities to root organizations in place and control their behavior through informal means. This research suggests that while a community can do little to change the physical distance between itself and an absentee managed plant's headquarters, it can reduce the social distance between itself and the plant by incorporating the latter in a dense network of local organizations where citizens often meet and discuss community problems. Through their involvement in these organizations, absentee managed plants may come to identify with their host community and work to maintain its physical integrity.

In this paper, I seek to demonstrate that absentee managed plants emit fewer toxins when embedded in communities that are more civically engaged. At the same time, I argue that right-to-know proponents and civil society theorists espouse two different models of civic engagement. Hence, I compare the effects of the local institutions that they allege facilitate the civic engagement of pollution. Specifically, I contrast the effects of states' new right-to-know programs with those of more traditional institutions -- i.e., voluntary associations, churches, and so-called third places (i.e., barber shops, cafes, and other informal sites of public life).

Until recently, it was impossible to determine the environmental effects of absentee management or any other organizational form because there were no organizational data on pollution. However, using the Environmental Protection Agency's Toxics Release Inventory – the same data that facilities must submit under the Emergency Planning and Community Right-to-Know Act – (using these data) I am able to test for the first time the effects of absentee management on the emissions of chemical plants in the United States. I focus on the chemical industry because it is responsible for a disproportionate share of toxic releases. Also, as a result of plants continuing to migrate from the corporate centers of the Rustbelt region to Sunbelt states, and other plants owned by foreign firms moving to the U.S. to seize new investment opportunities, an unprecedented number of chemical plants in this country now have out-of-state headquarters.

To situate my study in its broader context, I next review competing perspectives on the environmental performance of absentee managed plants offered by proponents and critics of globalization (OVERHEAD). Proponents suggest that plants with remote headquarters often use more efficient and cleaner technologies than locally managed ones. They argue that as companies mature and develop standardized production processes, they decentralize their branches to periphery regions to capture the efficiencies of their best input-saving technologies. Proponents of globalization also contend that multi-locational firms typically have more uniform operating procedures and greater resources to invest in environmental initiatives. They suggest further that because environmental groups are eager to sue companies capable of paying large settlements, the satellite plants of major corporations are under intense pressure from their headquarters to manage their chemicals as effectively as possible and perhaps even overcomply with regulations.

In contrast, critics of globalization argue that firms are increasing their power by decentralizing production, a phenomenon Harrison describes as "concentration without centralization." According to these scholars, firms often relocate plants to distant areas as a way to avoid regulation and externalize their pollution. They suggest, therefore, that absentee managed plants are among the dirtiest. Dependency researchers, for example, argue that the maquiladoras created in the free trade zones of northern Mexico and other parts of Latin America are especially poor environmental stewards. They predict that as international competition for jobs intensifies, developing countries will feel pressure to create additional "pollution havens" to attract plants. The same dynamic allegedly operates within the United States, where many chemical firms have tried to flee costly regulations and fend off foreign competition by relocating plants in the "better business climates" of southern and southwestern states. This strategy reinforces an already strong tendency among multi-locational businesses to stress the exchange value of natural places over their potential use values, i.e., to treat them as expendable commodities. Consistent with this reasoning, Davis (1992) finds that the owners of chemical companies with multiple out-of-state plants are significantly less willing to sacrifice production to meet environmental standards.

So, which group is right? FIGURES 1 and 2 provide a preliminary answer to this question. They report how the emission[1] levels of chemical plants with out-of-state[2] headquarters compare with the emission levels of other chemical plants in the year 2000 according to the Toxics Release Inventory. Since the TRI's inception in the mid-1980s, the number of industrial chemicals determined to be toxic and therefore tracked by the EPA has more than doubled from 319 to 667. Figure 1 compares the amount of toxins released by different plants using the EPA's original list of 319 or core chemicals. It shows that the average emission level of plants with out-of-state headquarters (4.2 million toxic pounds) is approximately 25% greater than the average emission level of other plants (3.4 million toxic pounds). Figure 2 shows that when we use the expanded or current list of toxins, the differences between the two plant types are even more pronounced. Absentee managed plants' average emission level (9.9 million toxic pounds) is roughly 57% more than that of other plants (6.3 million toxic pounds). Hence, there is empirical support for critics' claim that toxic emissions are concentrated in plants that are managed from afar.

Of course, it could be that absentee managed plants emit more toxins, on average, simply because they use more toxic chemicals. That is, firms may be emboldened to process larger quantities of dangerous chemicals when they can do so from a safe distance. Hence, when one takes into account the amount of toxins that plants have at their disposal, it may be that plants with distant headquarters are no more prone to pollute than other plants. Even so, the total amount of toxins emitted by plants is of paramount importance to local communities. Also, while communities may be unable to set formal limits on how many toxins a plant processes, communities can informally pressure a plant to minimize its toxic releases. Whether communities can reduce the emissions of plants with the *least* attachment to place – absentee managed ones – is the focus of this inquiry.

As suggested earlier, in assuming that communities are powerless to outside organizations, critics ignore recent legislation designed to empower local citizens as regulators. In particular, the Emergency Planning and Community Right-to-Know Act marks a significant departure from traditional regulatory policy. Instead of specifying the pollution reduction methods to be used by industry, which had been the practice under previous command-and-control approaches, this act seeks to reduce industrial pollution by disclosing information on manufacturers' pollution behavior. Specifically, it requires all states to establish a system of Emergency Planning Committees, which are to take data on the hazardous materials used by local manufacturers and make that information available to inquiring citizens. The assumption underlying this "regulation through information" approach is that local residents will be able to use pollution data to exert pressure on manufacturers to lower their emissions.

Critics also ignore recent research on civil society. This work suggests that businesses rarely operate in a social vacuum. Rather they are subject to demands from several other kinds of organizations, including their host communities. This research stresses the fact that communities have always possessed problem solving capacities and local institutions such as churches, associations, and "third places" have long served as forums for civic engagement. These institutions have thus helped to root actors to places and enhance the local quality of life.

While both literatures concur that civic engagement matters for the environment, they disagree over the mechanisms involved in the civic engagement of pollution and whether civic engagement is more relevant to some businesses than others. They also stress the importance of different local institutions for facilitating civic engagement and reducing industrial pollution. Indeed, I would argue that they subscribe to TWO DIFFERENT VERSIONS of the civic engagement thesis.

Proponents of the regulation through information approach subscribe to what might be called a strong version of the civic engagement model, which suggests that state-sponsored institutions like right-to-know programs enable citizens to voice their grievances and organize public protests against polluters. A strong model of civic engagement also assumes that because manufacturers in general tend to pollute, right-to-know programs should improve the environmental performance of plants regardless of their ownership status. Hence, it would predict that civic engagement in the form of state-sponsored right-to-know programs lowers the emissions of all plants.

In contrast, civil society scholars tend to subscribe to a qualified or weak version of the civic engagement model that emphasizes how local institutions function to coopt certain types of businesses. This model suggests that civic communities emerge out of local clusters of small, locally owned and managed establishments. While not denying that large corporations can and do operate in such communities, it contends that without a class of small business owners, the odds of establishing a civic community are considerably less. Thus, it argues there are two types of communities or local economies, those largely organized by corporate capitalism and those by community capitalism. Workers in the former tend to look outward to the global economy and their allegiance lies more with the firm than the community. Workers and residents of the latter look inward to the community since it is their primary source of support.

According to a qualified version of the civic engagement model, civic communities are best understood as "problem solving" places and the local institutions where citizens most often assemble and address community problems are voluntary associations, churches, and "third places". From this perspective, civic institutions provide not so much a format for venting grievances as they create venues for citizens to solve mutual problems like pollution. These problems can be resolved amicably or though direct confrontation. The point is that the more such problem solving places exist in a community, the better equipped a community will be to solve problems that face it.

It follows that the problem solving capacity of local communities has special importance for the environmental performance of absentee managed plants. Absentee managers have no motive to behave in a socially and environmentally responsible fashion and therefore will pollute if they can. Local managers would like to pollute but they do not feel they can because they have more personal and material ties to their host community and are integrated in its structures. Local institutions are important, then, because they smother absentee managed plants and their managers with social pressure to behave appropriately in the absence of strong local connections. Thus, they compensate for the lack of such ties. Hence, a weak version of the civic engagement model would predict that civic engagement in the form of associations, churches, and "third place" lowers the emissions of just absentee managed plants.

While the idea that civic engagement can protect communities from all or a subset of polluters is reassuring, SERIOUS DOUBTS nonetheless remain. First, arguments about the environmental benefits of civic engagement stand in dire need of empirical analysis. In the few cases where pollution outcomes have been examined at all, researchers have looked at emissions at highly aggregated levels of analysis (e.g., industry, state, nation). Consequently, it is still unknown whether states' right-to-know programs or the types of local institutions stressed by civic society theorists have any real effect on the environmental performance of individual plants. Nor has it been shown that such effects exist net of other plant characteristics that are thought to increase pollution.

Second, some argue that while there are demonstrated benefits of civic engagement for individuals (e.g., for finding jobs and avoiding crime), to suggest that civic engagement is also a property of communities borders on circular reasoning. They note a common tendency among researchers to examine positive outcomes, like low rates of crime, poverty, or pollution, and then infer the existence of civic engagement from the same outcomes.

Finally, research on civic engagement has been criticized for ignoring how factors like class and race may account for both civic engagement and its effects (Skocpol 1996, p. 25).

Our study seeks to address these concerns. First, we empirically model the impact of civic engagement on chemical plants' emissions. In the process, we address Portes's complaints about circularity by treating the factors that facilitate civic engagement as separate from their effects. It is probably true that civic engagement cannot be exactly measured at the community level. However, we are able to examine the relationship between pollution and what scholars claim are some of the institutions that facilitate civic engagement -- i.e., states' right-to-know programs, associations, churches, and "third places." Finally, we test these indicators of civic engagement alongside measures of race and class that may explain the former's impact.

DATA AND METHODS

To determine whether the emissions of all or just absentee managed plants are conditioned by civic engagement, a data set was constructed that incorporates measures of chemical plants' toxic releases and predictors of those releases. The unit of analysis for this study is the chemical plant and the data file consists of 1859 cases.   Since it is at the site of production that industrial toxins are usually emitted, and absentee management is an attribute of individual plants, we focus on pollution outcomes at the plant level rather than the firm level.[4] We conduct a cross-sectional analysis of emissions in 2000 because the remoteness of a plant's headquarters is not likely to fluctuate much from one year to the next, nor is the civic engagement of a plant's surrounding community.[5] However, in other analyses not reported here, we looked at emission outcomes for 1990 and found the results to be virtually the identical.

As TABLE 1 indicates, our dependent variable is taken from the EPA's Toxics Release Inventory and is operationalized as the annual pounds of chemicals released on-site (weighted by their toxicity). Plants with high scores on this measure are those with high emission levels.   To determine if the causes of emissions differ depending on whether one uses the EPA's original list of chemicals or its more recent, expanded one, we conduct separate analyses of each. Because toxic emissions are highly skewed, we transform the dependent variable when conducting our regression analyses by taking its natural logarithm.

One feature of the Toxics Release Inventory is that it lists for each plant a unique nine-digit identifier assigned by the Dun and Bradstreet Company. This number, in conjunction with the listed address of each plant, allows one to append to the TRI organizational data compiled by Dun and Bradstreet on each plant, including whether it is absentee managed.

Absentee managed plant is coded as a dummy variable (1=yes) and defined as any chemical facility whose headquarters is located out-of-state.[6]

Another key independent variable, *right-to-know funding*, is operationalized as the number of years since a plant's state first funded its right-to-know program under the Emergency Planning and Community Right-to-Know Act. Under this act, states are not provided any federal money to create their right-to-know programs. Hence, our measure is designed to distinguish states that have a real and long-term financial commitment to disseminating pollution information from those that run more nominal programs. Importantly, we do not claim that this variable measures actual citizen mobilization. Rather it is intended to capture the kind of local regulatory environment in which a chemical plant now operates that supposedly empowers citizens as regulators. According to the strong version of the civic engagement thesis, this variable should vary inversely with the emissions of all chemical plants.

To test the weak version of the civic engagement thesis, we interact our measure of absentee managed plant with three indicators of civic engagement institutions -- (log) number of associations, (log) number of churches, and (log) number of third places in a plant's county. While none of these three indicators directly measures the mechanisms said to be involved in the civic engagement of pollution, they do gauge the presence of institutions said to facilitate social connectedness and problem solving. Each of these three indicators is expected to have a negative statistical interaction with absentee managed plant or reduce just the latter's emissions.

Our models also control for several other industrial, political, demographic, and organizational factors that are summarized in Table 1 of your handout. We conduct analyses of the determinants of emissions using a random effects model available in LIMDEP.

FINDINGS

TABLE 2 examines the determinants of chemical plants' emissions using the EPA's original list of toxins or "core chemicals." Looking first at the controls in model 1, we see that log emissions are significantly lower when plants specialize in soaps/detergents. Conversely, log emissions are significantly higher when plants have more chemicals on-site and they and their parent firm are large. Contrary to what one might expect, the race and class characteristics of a plant's surrounding neighborhood are unrelated to the emission of core chemicals.[9]

Most importantly, we see that net of the various controls, absentee managed plant has no significant direct effect on log emissions. Other analyses not reported here revealed that the inclusion of log toxic chemicals on-site changed the effect of absentee managed plant from positive and significant to non-significant. This suggests that absentee managed plants have higher emission levels – as we saw earlier in Figure 1 – in large part because their potential for emissions is so much greater.

Findings from model 1, therefore, suggest that critics and supporters of globalization are both wrong -- absentee management per se has neither a harmful nor a beneficial impact on environmental performance. Still, communities have a special stake in minimizing the emissions of absentee managed plants precisely because the latter use such large quantities of chemicals.

This raises the question of whether certain types of communities are more successful than others at lowering the emissions of absentee managed plants or the emissions of all plants. Contrary to the expectations of the strong version of the civic engagement thesis, other results in model 1 indicate that local right-to-know programs have no direct bearing on the log emissions of all plants. Neither do log associations, log churches, and log third places. However, a qualified version of the civic engagement model suggests that the latter three factors may still condition the environmental performance of those plants with the weakest ties to communities -- absentee managed ones. In models 2 through 4, we explore this possibility by interacting absentee managed plant, respectively, with log associations, log churches, and log third places. Results indicate that the emissions of absentee managed plants are significantly lower when they are located in counties with more associations (model 2), churches (model 3), and third places (model 4).

In TABLE 3, we replicate our analysis of the determinants of emissions but this time using the EPA's more comprehensive list of toxic chemicals. In model 1, we see, as before, that plants have significantly lower emissions when they specialize in soap/detergents and higher emissions when they process more chemicals, are large, and their parent firm is large. Interestingly, when using the more recent, expanded list of chemicals, plants have significantly higher emissions when located in poorer neighborhoods. While one cannot generalize from this finding that poor neighborhoods are exposed to more absolute amounts of toxins, it does speak to how class influences the emissions of plants and the possibility that as more chemicals are added to the EPA's list of toxins, the environmental dangers faced by poor communities will become more obvious.

In model 1, we see once again that the effect of absentee managed plant is non-significant when controlling for other relevant factors, in particular the amount of toxins that a plant uses and stores on-site. The latter suggests that absentee managed plants release more toxins back in Figure 2 because they have more toxins at their disposal. Indeed, on average, absentee managed plants have on-site well over twice as many toxic chemicals than locally managed ones, 36 trillion toxic pounds compared to 14 trillion.

We also find support for the qualified, but not the strong, version of the civic engagement thesis. Right-to-know programs exert no significant, direct effect on the emissions of chemical plants, whereas the other three indicators of civic engagement have significant, negative interactions with absentee managed plant, suggesting again that they lower the emissions of plants with distant headquarters.

The negative sign of the interaction term in model 2 indicates that absentee managed plants have significantly lower emissions when nested in counties with numerous associations. In more substantive terms, as TABLE 4 shows, if there are no associations in a plant's county, the absentee management effect is .186 ($b_x + (b_{xy})Z$); if 10 associations, the effect is -.082; if 50 associations, the effect is -.271; and so on. This suggests that only a small number of associations needs to be in place before absentee managed plants begin to reduce their emissions. Table 4 provides similar statistics for the interaction effects of churches and third places.

Importantly, all of the interaction effects in Tables 2 and 3 hold after controlling for a variety of industrial, political, socio-demographic, and organizational factors that might explain them. That associations, churches, and third places each reduce the emissions of absentee managed plants speaks to how social connectedness in a variety of institutional forms benefits communities' physical environments. In sum, findings in both Tables 2 and 3 support the prediction of the weak version of the civic engagement model that absentee managed plants pollute less when embedded in civically engaged communities.[12]

Before leaving these results, let me note that we conducted several other analyses to determine whether states' right-to-know programs had any effect. We tested their interaction with absentee managed plant, we controlled for prior 1990 emissions to see if they affected changes in emissions, we looked at emissions in just 1990, we experimented with different measures of states' right-to-know programs, and so on. In every instance, results indicated that states' right-to-know programs have no significant direct or indirect bearing on the emissions of chemical plants net of other factors. This non-finding is an especially important one, because, as this FIGURE 3 indicates, if you were to just compare the average emissions of plants in states that have and have not funded their right-to-know programs in every year, you would be misled to believe that these programs actually make a difference.

CONCLUSION

To conclude, our findings are by no means the definitive word on absentee management and its interaction with community structures. Our analysis, for example, says nothing about the economic/environmental tradeoffs local communities sometimes make when deciding whether to recruit absentee managed plants. We have only considered absentee management as it manifests itself within the United States and therefore cannot say how absentee managed chemical plants might impact the environment in less developed nations.

As mentioned earlier, we also do not directly test the mechanisms involved in the civic engagement of pollution. It could be that local institutions decrease the emissions of absentee managed plants because they instill in them a greater sense of *loyalty* to their social and physical surroundings. It may be that these institutions give citizens more opportunity to *voice* their grievances. Or absentee managed plants with high emission levels may tend to *exit* or avoid civically engaged communities.[14] Until more detailed data become available, we have no way of determining which of these possibilities is more true.

These caveats notwithstanding, our study makes several SIGNIFICANT CONTRIBUTIONS.

First, in identifying which types of plants are most likely to pollute and under what conditions, our results are of great practical value in that they should help inspectors, state emergency response commissions, and the Chemical Manufacturers Association decide *where* to allocate their resources.

Second, our findings cast doubt on the efficacy of environmental federalism and states' right-to-know programs in particular. The fact that the latter have no effect on emissions in one of the dirtiest industrial sectors – chemicals – is striking and raises the question "Is the more decentralized regulatory environment in which polluters now operate real or illusory?"

Third, and on a more positive note, results suggest that although today's global economy is dominated by mobile employers, industry rarely is all-powerful and community-based forms of regulation are still viable. Communities possess problem solving capacities that can be activated to limit the destruction caused by businesses, especially those with the least attachment to place. However, the kinds of local institutions that facilitate the civic engagement of pollution may not be the ones that policymakers expect.

Fourth, our study suggests how organizational research might be advanced. It has become fashionable for organizational scholars to use biomaterial metaphors like embeddedness to describe and bound organizational properties. Yet, these terms say precious little about how such properties, in turn, influence real biomaterial outcomes. By following our lead and studying the environmental damage caused by nested organizational structures, researchers may discover the ecological significance of concepts like embeddedness and what makes an organization truly sustainable.

Finally, our empirical analysis greatly improves on past environmental studies that merely <u>speculate</u> about the pollution effects of absentee management and other organizational factors. By combining EPA data on facilities' emissions with information on their characteristics and those of their host communities, we have pioneered, I believe, an exciting possibility for secondary research. Our study also underscores the need to study organizations where they most immediately impact the environment – the plant level.

There are no doubt other organizational forms besides absentee management that influence plants' environmental performance. Indeed, the study presented here is but one part of a larger project funded by the EPA that investigates the pollution effects of several organizational forms. For instance, another organizational factor that we examined and discovered increases emissions is whether a plant is a subsidiary. This is an important finding because it speaks to the possibility that in allowing parent companies to create a "liability firewall" between themselves and their branches by reclassifying the latter as subsidiaries, the 1986 Tax Reform Act may have inadvertently encouraged parent firms to shift their most environmentally dangerous production activities into subsidiaries.

So, there are other organizational forms that might be studied. Likewise, the pollution outcomes studied here are not the only ones that can now be examined at the plant level. In future research, I plan to examine the organizational and communal determinants of plants' emissions using the EPA's newly released Risk-Screening Environmental Indicators or RSEI. Unlike the pollution data used in this study that gauge simply the pounds of toxins released by plants and their relative toxicity, RSEI data also take into account the degree to which people are potentially exposed to chemicals and the estimated size of the exposed population. RSEI data thus provide much more accurate measures of the potential risk-related impact of facilities on chronic human health. Using these new data, I plan to investigate the possibility that right-to-know programs may still reduce the most serious health-related emissions. I also plan to address an important but underresearched question in the environmental justice literature, which is What is it about the organization of hazardous facilities that explains why some pose a greater health threat in poor, minority neighborhoods than others? In short, we're entering a new phase of environmental and organizational research when several key empirical issues can finally be addressed.

that seeks to explain why some plants pollute more than others. For instance, another organizational factor that we examined and discovered increases emissions is whether a plant is a subsidiary. This is an important finding because it speaks to the possibility that in allowing parent companies to create a "liability firewall" between themselves and their branches by reclassifying the latter as subsidiaries, the 1986 Tax Reform Act may have inadvertently encouraged parent firms to shift their most environmentally dangerous production activities into subsidiaries. We have also begun examining whether chemical plants with the weakest local ties – those owned by foreign companies – pollute more.

Finally, I hope

In future research I plan to gain further insight into the determinants of facility-level emissions using the EPA's newly released Risk-Screening Environmental Indicators. Unlike the pollution measures used in this study and others that gauge simply the pounds of toxins released by facilities and their relative toxicity, RSEI data also take into account the degree to which people are potentially exposed to chemicals and estimated size of the exposed population. Thus, RSEI data provide much more accurate measures of the potential risk-related impact of facilities on chronic human health. Using these new data, one can address an important but grossly underresearched question in the environmental justice literature, which is What is it about the organizational features of hazardous facilities in disadvantaged neighborhoods that explains why some endanger human lives more than others. In short, we're entering a new phase of environmental and organizational research when these and other issues can finally be examined empirically. I'll stop on that forward looking point.

Of course, the big issue is whether certain kinds of plants pose a greater health risk. The measure of pollution used in this study only gauges the pounds of toxins released by a facility and their relative toxicity. Fortunately, the EPA's newly released Risk-Screening Environmental Indicators allows one to do this and more – i.e., it also takes into account the degree to which people are potentially exposed to chemicals and the estimated size of the exposed population. Using these data, I plan in future work to address a key yet underresearched question in the environmental justice literature, which is what

What is it about the organizational features of hazardous facilities that explains why some in the same disadvantaged neighborhood

pose a greater health risk to disadvantaged neigh

in disadvantaged neighborhoods that explains why some endanger human lives more than others.

Also, depending on how many of these institutions are present, a community may or may be able to curb the emissions of plants with the weakest local ties.

Fourth,

First, its empirical analysis greatly improves on past studies by environmental and organizational sociologists that merely <u>speculate</u> about the pollution effects of absentee management. By combining EPA data on facilities' emissions with information on their host communities, we have empirically demonstrated for the first time that the spatial properties of plants have important environmental consequences and the local conditions under which this is especially true. Our study should also sensitize researchers to the need to study organizations where they most immediately impact the environment – the facility level.

Second, our findings inform work on globalization and the spatialization of capital. Prior research has noted how capital mobility can create new forms of locational concentration (Sassen 1991) or "sticky spaces in slippery space" (Markusen 1996). Our study compliments these studies by suggesting how local institutions help root absentee managed facilities in place and minimize their environmental destruction. Likewise, our research resonates with recent theorizing about the spatialization of the U.S. economy (Grant 1994; Brady and Wallace 2000) and the "spatial decentralization" of production (Romo and Schwartz 1995). But whereas this body of work stresses how footloose employers have severed their postwar accord with workers and citizens, our study suggests that a new accord may be possible that is grounded in social capital. This does not imply that a move toward a less capable and involved national government is required for civic engagement to thrive, as conservatives have suggested. Nor does it mean that translocal agents (e.g., NGOs, social movements, political parties) will not play a role in creating livable places (see Evans 1997; Putnam 1993, p. 176). Rather, our results suggest that in the present global period, viable compromises between employers and workers/citizens might still be constructed at the local level. In light of the recent concerns raised about the relevance and efficacy of civic engagement (Portes 1998; Skocpol 1996, p. 25), this is promising news for communities within the U.S.

Finally, and perhaps most importantly, our study demonstrates that if scholars are to study the impact organizations have on the environment (Perrow 1997), they must consider not simply the characteristics of businesses but those of other organizations with which businesses interact. As research on structural embeddedness and civil society suggests, communities are also strong organizations and how they cultivate the problem solving capacity of their citizens can strongly influence the behavior of external organizations like absentee managed plants. While our study cannot say whether more amicable or contentious strategies work best with absentee managers, it speaks to the more fundamental point that communities function as problem solving places. Indeed, although today's global economy is dominated by mobile employers, industry rarely is all-powerful. Communities possess organizational resources that can be activated to limit the destruction caused by businesses, including those with the least attachment to place.

NOTES

[1] Emissions, which are reported in pounds by the EPA, are weighted here by their toxicity (see Grant, Jones, and Bergesen 2002 for details on toxicity weights).

[2] In the context of this study, "out-of-state" is not meant as an indicator of globalization, but absentee management.

[3] Unlike many other pollutants, which are subject to strict safety standards, the Environmental Protection Agency only requires manufacturers to report their toxic releases, leaving it up to local communities to act on that information as they see fit.

[4] Examining emissions at the firm level would also introduce several complications, since firms may own plants in several industries with very different eco-organizational properties.

[5] We explored the possibility of examining changes in emissions between 1990 and 2000, but several factors discouraged us from doing so. In particular, because of changes in reporting requirements and the fact that hundreds of new toxins have been added to the TRI list of chemicals since 1990, the facilities included in the 1990 and 2000 Toxics Release Inventory are often not the same. Indeed, a plant that processes the same chemical and in the same amount in these two years, may be required to report information on emissions for just one of these years. Importantly, we did replicate our 2000 analysis with 1990 data using the core list of chemicals and found the results to be basically the same. Hence, although the chemical plants included in the 1990 and 2000 Toxics Release Inventory may differ, the pattern of relationships between emissions and other factors appear robust across the two time points.

[6] Grant et al.'s (2002) analysis of 1990 data tested the effect of branch plants in general and therefore did not isolate the pollution behavior of branches with out-of-state headquarters. By distinguishing absentee managed plants from others, we are able to test the thesis advanced by critics of globalization and capital migration that the *spatial* characteristics of plants have important environmental consequences.

[7] A related study examines the emission rates of foreign owned plants in the United States (Grant and Jones forthcoming). It, however, focuses on a small subset of all absentee managed plants and with 1990 data that excludes roughly half of the industrial toxins now tracked by the EPA. Nor does it address the key question of this paper, which is whether the environmental performance of absentee managed plants varies by the local civic cultures in which they are embedded. Hence, it examines the effects of absentee management in a very preliminary fashion.

[8] The sources of these indicators are the Encyclopedia of Associations 2000 (Gale Research Corp. 2000), Census of Churches (Association of Statisticians of American Religious Bodies 2002), and the County Business Patterns (U.S. Bureau of the Census 2002).

[9] We also considered the possibility that past environmental fines might influence emissions but discovered that because less than .005% of plants had ever been penalized, this factor could not be included in our models without creating severe problems of multi-collinearity.

[10] In substantive terms, findings suggest that if there are no churches in a plant's county, the absentee effect is .467 ($b_x + (b_{xy})Z$); if 10 churches, the effect is .115; if 50 churches, the effect is -.131; if 100 churches, the effect is -.238; and if 1000 churches, the absentee effect is -.590 (the sample range for churches is 2 to 4044). Results indicate that if there are no third places in a plant's county, the absentee effect is .307 ($b_x + (b_{xy})Z$); if 10 third places, the effect is .049; if 50 third places, the effect is -.130; if 100 third places, the effect is -.209; and if 1000 third places, the absentee effect is -.467 (the sample range for third places is 0 to 12773).

[11] Importantly, Tolbert et al. (1998) suggest that their indicators of civic engagement probably underestimate the importance of local institutions that are older and have especially deep roots in community.

[12] We experimented with other specifications of the dependent variable such as expressing emissions as a fraction of all chemicals on-site (log(emissions/chemicals on-site) and discovered that the results mirrored those for log emissions.

[13] For example, if one were to estimate simultaneously the determinants of emissions, the siting of absentee-owned plants, and housing segregation (Hefland and Peyton 1999; see also Downey 2003), it might be found that race and ethnicity are significant predictors of emissions. However, the type of longitudinal data needed for such a simultaneous equation are unavailable or limited.

[14] Although, to our knowledge, nowhere in the literature on industrial location has it been suggested or shown that civic engagement actually influences the siting of chemical facilities.

Everyone is remarkably well preserved. You look just the way I remember you. And it's equally great to meet others who been hired since and helped to take the dept., in many respects, to a new level of excellence
questions: 1) Do absentee owned plants or plants with distant headquarters emit more toxins than local managed ones? and 2)

My funded project seeks to address two basic questions: 1) how does the ownership status of a regulated facility affects its environmental performance?, 2) what the implications of this for the effectiveness of community-based forms of regulation? Today, I will be talking about a portion of this larger project that looks at absentee owned plants and how their environmental performance is conditioned by right-to-know programs, and other types of local civic engagement.

There are few human-made environmental problems that are not caused by or through organizations (Perrow 1997; Clarke 1989). While individuals' lifestyles, consumption habits, and so on contribute to environmental degradation (York, Rosa, and Dietz 2003), many, if not most, pollutants are emitted at the site of production or have their source in industrial organizations. And yet sociologists have rarely examined the impact that different organizational forms have on pollution

Today, I will be talking about a portion of a larger project funded by the EPA that examines how the ownership status of a facility affects its environmental performance and the implications this has for community-based forms of regulation. Specifically, I will address two questions: 1) Do absentee owned plants or those with distant headquarters pollute more? and 2) What effect, if any, do right-to-know programs and other local channels of civic engagement have on these plants' emissions?

This is true in developing countries where pollution is often unregulated by national governments and local communities must therefore negotiate environmental standards with manufacturers (Hartman, Huq, and Wheeler 1997). It is true as well in developed countries where command-and-control approaches to regulating industrial toxins have been slowly replaced by strategies that rely on the participation of local citizens (Ringquist 1995).

Actually, my talk today is essentially the same one I gave just 3 days ago in D.C. at the EPA's Conference on .

We also show that states' new right-to-know programs have no effect on the emissions of absentee managed plants. Rather their environmental performance depends on the presence of other local institutions that have traditionally facilitated civic engagement, namely churches, voluntary associations, and so-called third places.

[The study I will present today is part of a larger research project funded by the Environmental Protection Agency on the organizational determinants of pollution and effectiveness of community-based forms of regulations. Specifically, my talk addresses two questions: 1) Do plants with distant headquarters pollute more? and 2) Can civically engaged communities do anything about it? Is the environmental performance of these absentee owned plants conditioned by the civic engagement of their host communities?

Social scientists have long speculated that]

The study I will present today is part of a larger research project funded by the Environmental Protection Agency on the organizational determinants of pollution and effectiveness of community-based forms of regulations. Specifically, my talk addresses two questions: 1) Do plants with distant headquarters pollute more? and 2) How is the environmental performance of these absentee owned plants conditioned by the civic engagement of their host communities?

In addition, there is a substantial body of empirical research that suggests absentee managed plants influence social outcomes, including poverty, infant mortality, industrial conflict, and underdevelopment. Whether absentee managed plants also impact environmental outcomes has yet to be determined.

***use later I report findings using the 2000 edition of the Toxic Release Inventory both because it is the most current and it covers more than twice as many industrial toxins than earlier editions. We focus on the U.S. for reasons of data availability and because the spatial restructuring of production has been especially great in this country during the global era. As a result of factories migrating from the corporate centers of the Rustbelt region to the "better business climates" of the Sunbelt states in response to global competition and other plants operated by foreign firms moving to the U.S. to seize new investment opportunities, an unprecedented number of plants in the U.S. are now absentee managed.

***

We study the effects of absentee management at the facility (as opposed to firm) level because industrial toxins are emitted at specific production sites and the environmental performance of individual facilities is of more immediate concern to local communities.

*** In conclusion where I discuss practical relevance, mention World Bank

**Write long version for OSU, then whittle it down for EPA (*where EPA talk begins, etc.)
In conclusion, note that this study was part of a larger project funded by EPA (I also examined other organizational forms)

** If this sounds like a talk you might give to policymakers, that is because it is.

** in other analyses, we examined whether plants with the most distant headquarters pollute more, but found that not to be the case.

Particularly relevant to our study, scholars at the World Bank have begun exploring how civic engagement affects the emissions of individual facilities (Hartman, Huq, and Wheeler 1997; Pargul and Wheeler 1995; Pargal, Hettige, Singh, and Wheeler 2002). They contend that in developing countries, where formal regulation (e.g., uniform air quality standards, mandated pollution technologies) tends to be weak or non-existent, informal regulation exercised by communities (e.g. public appeals, protests) may strongly influence corporate environmental performance. They speculate that civic engagement may also influence certain types of corporate pollution in the U.S. that are largely unregulated, such as toxins released by manufacturers.[3]

In short, a growing body of research suggests that communities can improve the environmental performance of manufacturing plants by reducing the social distance between themselves and plants. According to this work, unless plants develop social ties to their host communities, they are unlikely to participate in public conversations about local environmental priorities. However, where there are numerous institutional settings that allow residents and plant managers to meet and develop a common appreciation of place, plants are more likely to participate in public conversations about the environment and curb their emissions.

It may also be that because pollution data are self-reported, the EPA needs to use better quality control measures. If more intentional and unintentional mistakes made in submitting information are caught and corrected, the effectiveness of right-to-know programs might be more apparent. There is also the possibility that existing pollution data are basically sound but how they are processed and interpreted by intermediaries, such as interest groups, varies widely. Along these lines, other studies report that the goals of regional environmental groups and local citizens often conflict.

As I explained to EPA officials and other policymakers at a conference in D.C. just three days ago, it might still be the case that states' right-to-know programs work in other sectors of the economy than the one studied here. Nonetheless, the fact that such programs cannot explain emission decreases in one of the dirtiest sectors – the chemical industry – is striking. It begs the question of what might explain recent reductions in emissions if not states' right-to-know policies? It could be, as some industry spokespersons suggest, that most of these improvements were the result of businesses themselves taking the initiative in devising environmental solutions. However, empirical support for this claim is thin and limited to qualitative studies of a small, select set of chemical companies (Baram et al. 1990). Another possibility is that changes in emissions are due to the efforts of national actors – e.g., the news media and organizations like Environmental Defense (see U.S. Environmental Protection Agency 2003). Previous research has shown, for example, that when national news media report the emissions of major companies, it can cause the value of their stocks to drop (Hamilton 1995). Whether companies respond to stock market declines by improving their environmental performance, though, has still to be determined. These and other possibilities need to be examined more systematically to determine whether the more decentralized regulatory environment in which polluters now operate is real or illusory.

findings suggest that community-based forms of regulation may still be viable in an age of globalization.

though the local institutions that facilitate the civic engagement of pollution may not be the ones policymakers expect. Nor do they influence the emissions of all plants.

Fourth, our study demonstrates that if scholars are to study the impact organizations have on the environment (Perrow 1997), they must consider not simply the characteristics of businesses but those of other organizations with which businesses interact. As research on structural embeddedness and civil society suggests, communities are also strong organizations and how they cultivate the problem solving capacity of their citizens can strongly influence the behavior of external organizations like absentee managed plants. While our study cannot say whether more amicable or contentious strategies work best with absentee managers, it speaks to the more fundamental point that communities function as problem solving places. Indeed, although today's global economy is dominated by mobile employers, industry rarely is all-powerful. Communities possess organizational resources that can be activated to limit the destruction caused by businesses, including those with the least attachment to place.

There is evidence consistent with each of these arguments. On the one hand, several studies document the success of states' right-to-know programs in educating their citizens and providing them with technical know-how needed to interpret and act on complicated pollution information. Others show that, on average, total emissions tend to be lower in states with more aggressive right-to-know programs. And the EPA reports that, for the nation as a whole, total pounds of on-site emissions have decreased by 56.6% since the Emergency Planning and Community Right-to-Know Act was passed (U.S. Environmental Protection Agency 2002).

On the other hand, several studies document how residents and business leaders become integrated in communities through their participation in volunteer associations, churches, and third places and how such civic engagement translates into lower rates of unemployment, poverty, and crime. Others studies suggest that these effects are especially strong in communities with many absentee managed businesses. And still others have demonstrated how corporate leaders, especially managers of satellite plants, can be persuaded to contribute to local environmental projects through their involvement in local religious and voluntary organizations.

Our goal in this paper was to advance our understanding of the environmental degradation caused by different organizational forms. Toward that end, we analyzed the effects of absentee management on chemical plants' environmental performance using the EPA's 2000 Toxics Release Inventory. Findings confirm the suspicion of critics of globalization that absentee managed plants emit greater amounts of toxins. However, results also indicate this is largely because absentee managed plants process substantially more chemicals. In fact, when we take into account the amount of chemicals that plants have on-site and other factors that influence facilities' emissions, we discover that the environmental performance of absentee managed plants is no worse than that of other plants. Whether plants with distant headquarters emit more chemicals largely depends on the presence of local institutions that facilitate civic engagement. Specifically, when embedded in communities with more associations, churches, and third places, absentee managed plants emit significantly fewer toxins.

Compliance and Beyond: Strategic Government-Industry Interactions in Environmental Policy and Performance – The Role of Technical Information in Reducing Automobile Emissions

Jennie C. Stephens and Edward A. Parson

Paper presented at the EPA Corporate Environmental Behavior Research Workshop, April 26-27, 2004

1. Introduction

Technical knowledge and associated uncertainty in technical feasibility play a critical role in government industry interactions during the development and implementation of environmental policy and regulation. Improvements in environmental performance are dependent on making technical changes to an industry's processes or products. While government takes actions to promote environmentally beneficial technological change to reduce industry's environmental impact, those targeted industries are generally reluctant to make technical changes unless they perceive an associated competitive advantage. Within this government-industry relationship characterized by this conflicting basic interest, technical information and its associated uncertainty are often integral to strategic interactive behavior. Firms identified as potential targets of regulation, either acting individually or cooperatively through industry associations, often use technical information as they seek to oppose, influence, or delay (and occasionally promote) environmental regulations. Governments seeking to formulate, enact and implement socially beneficial environmental policies must attempt to understand technological details and feasibility of technical alternatives although they often have limited independent information.

The design and implementation of government regulation to encourage technological change for environmental improvement involves a dynamic process whereby regulators and industry representatives interact and respond to each other (Yao 1988). While much of the literature examining the influence of government regulation on technology development provides useful insights on relative effectiveness of different regulatory mechanisms on innovative behavior (Kagan 1977; Ashford 1993; Kemp 1997; Jaffe, Newell et al. 2000; Taylor, Rubin et al. 2003), the complexities of industry-government interactions surrounding uncertainty associated with technological feasibility are often omitted at this scale of analysis. Recognizing the critical role that perceptions of technical feasibility of new technologies plays in both industry's attempts to influence government decisions and government's attempts to influence industry's decisions, this research focuses on the detailed interactions related to knowledge, uncertainty and technical details.

This paper explores the role of technical information in government-industry interactions in the fifty-year history of efforts to reduce automobile emissions. By simultaneously focusing on the strategic behavior of both the automobile manufacturing industry and the U.S. government, we are working toward identifying resultant characteristic patterns of outcomes that arise from the interactions. This case is one of six case studies, chosen to represent diversity in the targeted industry, government programs, historical time, pollutants and geographic relevance, that will be included in the final product of this research effort, a forthcoming book edited by Parsons and Stephens. The other five case studies included in this book explore strategic interactions between government and industry with respect to technical information during efforts to reduce: 1) dioxin in the pulp and paper industry, 2) perfluorocarbons in the aluminum manufacturing industry, 3) chlorofluorocarbons in the chemical industry, 4) methyl bromide in the agricultural strawberry and tomato industry, and 5) workplace exposure to vinyl chloride in the vinyl chloride industry.

This paper will first describe the historical details associated with government-industry interactions during each of the three time periods. A discussion of the unproductive cycle of mistrust that has developed over the years between the government and the industry is followed by discussions on the implications of cooperation versus competition within an industry and the critical role of third parties, and finally some concluding recommendations for policymakers that can be drawn from this case.

2. Three distinct Time Periods of Government-Industry Interaction

The history of the government's attempts to encourage the U.S. automobile manufacturers' to develop and implement technologies to reduce automobile emissions provides a particularly interesting perspective to improve understanding of government-industry interactions regarding technological information exchange because the history can be divided into three time periods with distinctly different industry-government relationships defining strategies of interaction (Figure 1). During the earliest period, before 1970, the federal government had minimal influence over the industry, and the industry resisted technological change primarily through an industry-wide cooperative agreement that removed competitive incentive to develop or implement pollution control technologies. During an intermediate period, after the passage of the unprecedented technology-forcing 1970 Clean Air Act Amendment (CAAA), competitive incentive among individual firms was restored and the industry was forced by the government to develop technology to meet specific emission standards in a predetermined (but subsequently and repeatedly extended) amount of time. During the most recent time period, from the debate preceding the 1990 CAAA until now, a more complex and less intense industry-government relationship has developed as many more actors have become involved in the more complicated technical and regulatory details. While industry resistance to technological change is clearly evident in all three time-periods, the industry strategies associated with this resistance have co-evolved with the changing regulatory framework and the changing industry-government relationship.

This paper reviews the empirical history and then highlights the most interesting observations about government-industry interactions within this history, while the full chronological details of government-industry interactions during these three time periods are described in more details elsewhere (Stephens 2004; Parson and Stephens Forthcoming).

2.1 The Early Years: Minimal Government Involvement, 1955-1970

When the automobile was first implicated as a major contributor to the urban air pollution problem in the early 1950s (Haagen-Smit 1952), the U.S. automobile manufacturers responded by creating an industry-wide, cooperative agreement which eliminated competition among individual firms to develop pollution control technology. This cooperative approach also severely restricted third party inventions through a cross-licensing agreement that specified royalty-free exchange of patents and a formula for sharing the costs of acquiring patents developed outside the industry; by removing incentive for industry consideration of third party inventions, the industry eliminated any potential market for third party innovators. Individual firms signed on to this cooperative agreement because it minimized the risk to them that another firm would gain competitive advantage by being the first to develop commercially viable pollution control technology (DOJ 1971). The following excerpt from the minutes of an April 1955 meeting of the patent Committee of the industry trade group, the Automobile Manufacturers Association (AMA) explains this strategy.

> *"No one company should be in a position to capitalize upon or obtain competitive advantage over the other companies in the industry as a result of its solution to this problem."* (DOJ 1971)

Despite the industry's public declaration that their cooperative program was designed to accelerate technical developments in emissions reduction, the opposite effect, to slow-down technical progress, has been identified as the intended result of the program by evidence collected during a grand jury investigation assessing antitrust collusion allegations against the industry in the late 1960s (DOJ 1971). Following this investigation, an antitrust civil suit alleging 16 years of industry conspiracy to prevent development of pollution control technology was issued; the case was settled by consent decree in which the industry did not admit to any illegal activity but did agree to a series of restrictions prohibiting the exchange of restricted technical information, prohibiting the issuing of joint announcements, and requiring open access to existing patents and technical reports to third parties, those outside the industry (1969).

During this early period of coordinated industry resistance, the emissions problem was perceived by the automobile industry as a management, public relations challenge, rather than a fundamental problem for which a technical solution had to be developed. This perception allowed the industry to successfully resist making changes by controlling the pace of technological development. The industry did slowly implement several simple technical solutions in response to public pressure and regulatory threats urging them to develop a technological response to the air pollution problem. One example of this is the industry's installation in 1963 of a simple valve that allowed for recirculation rather than direct release of pollutants from the crankcase; this positive crankcase ventilation (PCV) valve had been used in military vehicles for decades so it was not a new technology, yet the industry presented the development as a result of their diligent efforts to find technical solutions to the automobile emissions problem (DOJ 1971).

During this early period when the federal government had minimal influence over or interaction with the automobile manufacturers, the California state government began addressing the industry's resistance by encouraging the development of pollution control technology through state regulation. Recognizing the industry's slow pace of development and implementation of technological improvements, California passed legislation in 1960 that was designed to stimulate competition within and outside the industry and provide a mechanism for government regulators to review the subsequent technical developments. The Motor Vehicle Pollution Control Act (MVPCA) set strict emission standards, a 70% reduction in HC and a 57% reduction in CO, that were to be enforced one year after two satisfactory emission control devices were certified by the state to meet the standards; all new cars would have to install one of the certified devices (California 1960). In drafting this legislation, California legislators identified and addressed two critical mechanisms with potential to accelerate the pace of emissions control technology development and reduce the effectiveness of the industry's attempts to resist change: 1) the competitive pressure of third-party innovators, and 2) the asymmetry of information between regulators and the industry. The MVPCA was designed to reduce barriers to market entry of those developing pollution control technology external to the automobile industry by creating incentive by ensuring a market for devices certified to meet the standards (CAMVPCB 1965; Krier and Ursin 1977). At this time catalyst technology was a suspected possible technology, so in response to this legislation a period of intense catalytic research began as many catalytic chemists jumped at the opportunity to work toward this exciting potential application of catalytic technology (Lester 1983; Briggs 1984). By requiring a detailed state certification of all devices, the legislation also created a pathway for information sharing; in the certification process the state regulators gained the opportunity to evaluate the potential of different technical approaches developed.

In 1964, when four externally developed devices (three of which were based on catalytic technology) were certified by the state triggering enforcement of the emission standards the following year, the automobile manufacturers revealed to the state their own internally developed technical changes, which consisted of a series of engine modifications rather than catalytic technology. Once the state certified these industry developed engine modifications, the automobile companies each chose to implement their own internally designed approaches rather than implement the externally developed catalytic devices (Krier and Ursin 1977). So although this legislation motivated and encouraged third party inventors, the inventions were excluded from implementation because the potential market was removed once the state certified the industry developed technologies. Nevertheless, the technological progress that was made in the early 1960s by third parties was influential in demonstrating to both the industry and the government the potential of catalytic technology; this potential was incorporated into the 1970 federal legislation discussed in the next section.

Engineers involved in the development of the catalytic technology have suggested that if cooperative relationships among industry, government and third parties had existed, an effective combination of engine modifications and catalyst systems could have resulted in an efficient pollution control technology that could have surpassed the California standards by the mid-1960s (Briggs 1984). Instead the industry's engine modifications approach with a limited level of reductions prevailed while the catalytic technology with a far greater potential level of reductions was not developed for implementation until the industry had to respond to the more stringent federal regulations issued in 1970.

2.2 Industry Resistance within a New, Stringent Regulatory Regime: 1970 - 1988

Reacting to deteriorating urban air quality in many parts of the country and the industry's apparent reluctance to make voluntary technical changes to reduce automobile emissions, a frustrated federal government responded with an unprecedented, stringent technology-forcing set of regulations in 1970. The 1970 Clean Air Act Amendments

(CAAA) mandated emission reductions for hydrocarbons (HC) and carbon monoxide (CO) of 90% below 1970 levels by 1975, and for nitrous oxides (NOx) 90% below 1971 levels by 1976 (U.S. 1970). These standards were more stringent than the California standards discussed in the previous section, which required a 70 and 57% reduction respectively for HC and CO and did not include a NOx standard. Responding to the federal government's aggressive regulatory attempt to accelerate the development of pollution control devices, the auto manufacturers intensified their research efforts while simultaneously intensifying their resistance, highlighting potentially critical technical uncertainties in their claims that the standards could not be met in the designated time.

While the auto manufacturers took every opportunity to weaken and delay the standards throughout the 1970s, third parties, those external to both the U.S. government and the U.S. automobile manufacturing industry, played a critical role in reducing the effectiveness of the industry's strategies to resist change. To appease industry's concern about the technical feasibility of meeting the strict standards set in the 1970 CAAA, the legislation included two flexibility mechanisms: 1) automakers were allowed to apply for a one-time, one-year extension if they could demonstrate to the Environmental Protection Agency (EPA) administrator that the technology was not yet available, and 2) upholding the standards was contingent on the assessment of technical feasibility to be carried out by the National Academy of Science (NAS). These flexibility mechanisms provided two different avenues for third parties to influence the industry-government dialogue.

During the extension hearings the testimony of independent companies developing pollution control technology influenced both the industry and the government. Independent suppliers of catalytic converters (the primary technology considered capable of meeting the standards), provided manufacturer-conflicting testimony to federal regulators about the feasibility of implementing the new technology during the 1972 and 1973 hearings to consider whether or not the industry deserved an extension to meet the standards (EPA 1972). Additionally, technological developments made by several non-U.S. auto manufacturers provided regulators with a more optimistic perspective on the technological possibilities of reducing emissions than the one promoted by the U.S. automakers. Specifically Honda developed an alternative engine design (a stratified charge engine) that could meet the 1975 standards without a catalytic converter (Abernathy and Ronan 1978). Although initially the EPA denied the industry's request for an extension in 1972, the U.S. court of Appeals ordered the EPA to reconsider the automakers' request in 1973 and this time the one-year extension was granted. Although arguments of technical infeasibility were used in the 1972 hearings, the 1973 hearings focused more attention on the potential business catastrophe that could result if insufficient time was allowed for the transition to the new catalytic technology.

The second flexibility mechanism, the stipulation that upholding the standards was contingent on the NAS assessment of technical feasibility, incorporated another way for an independent entity, a third party, to influence industry-government interactions and reduce industry's resistance. The 1973 NAS report was extensively researched, and the auto manufacturers were required by law to respond in full to any requests for information of any kind from the NAS committee members (Lester 2003). The reports major conclusions were that the 1975 HC and CO standards could be met in the given time frame, but to meet the 1976 NOx standard additional time would be required (NAS 1973). The report reviewed technical obstacles to successful implementation of catalytic converters questioning whether the technology could be optimized by the 1975 model-year. A major quandary noted within the report was the recent development of Honda's stratified charge engine that could meet the 1975 standards with potential to meet the 1976 NOx standards too. This report provided regulators with an independent technical assessment of the feasibility of meeting the standards and also created a common-ground base of information to which the government and industry could both refer to in future debates.

In addition to Honda's technical developments minimizing the U.S. industry's claims of technical feasibility, other foreign automobile manufacturers were also influential. Although technical progress was being made in the early 1970s with the development of a catalytic converter that could successfully oxidize HC and CO, a major unresolved technical challenge was whether an effective device that could simultaneously reduce NOx could be developed. As it became clear in 1976 that the auto manufacturers were not going to meet the standards scheduled to come into effect for the 1978 model year an additional set of amendments to the CAA were debated. Initially during this debate, the industry emphasized the uncertainties, infeasibility, and potential drawbacks related to the development of a catalytic device that could successfully reduce all three regulated pollutants (HC, CO, and NOx), a so-called three-way converter. In mid-1976, however, Volvo produced a car to be sold in California with a three-way catalytic device able to meet all three standards. In response, the U.S. manufacturers shifted their resistant arguments away from claims of technical infeasibility focusing instead on the economic uncertainty of implementation and the technical challenges associated with scaling-up production; ensuring effective and safe catalytic converters on every new car, they argued, would require more time. The industry lobbying efforts were successful in preventing agreement in Congress on what revisions should include, so the actual amendments to the CAA were not passed until August 1977, when the automakers were already shipping out to the dealers their 1978 models which did not meet the current standards. The 1977 CAAA delayed the HC standard until 1980, the CO standard until 1981, and weakened and delayed the NOx standard to come into effect in 1981 (1977).

In the years following, the three-way catalytic converter was improved upon and became standard on most U.S. cars by 1980. Throughout the 1980s, the automobile industry's concern about emission control regulation reduced as President Reagan's administration demonstrated interest in weakening rather than strengthening pollution control, and Congress was deeply divided on the issue. In 1988 this situation changed as it became clear that additional changes to the air pollution legislation were necessary and inevitable (Cohen 1995).

2.3 A Mature Industry-Government Relationship: 1988 to present

Despite the success in the development of the three-way catalytic converter, air pollution continued to be a growing problem throughout the 1980s due to the increasing number of cars on the road (Taylor 1987). Following a decade of inaction on air pollution legislation, Congressional action began to be seriously debated in 1988 building upon proposals developed by a few key Congressmen during the 1980s (Bailey 1998). President George H.W. Bush, recognizing the political collateral associated with being the President who updated and strengthened the CAA, placed passing new air pollution legislation high on his priority list (Cohen 1995). Further reductions in automobile emissions was only one of three main goals of the 1990 legislation; the other two goals were to reduce acid rain by cutting sulphur dioxide and nitrogen oxides emissions and reduce emissions of air toxics by mandating control technology. With regard to automobile emissions, the 1990 legislation mandated phasing in the California emission standards at the national level in all new cars starting in 1994. These standards, known as Tier 1 standards, required a reduction in NOx emissions from 1990 levels of 60% and a reduction in HC of 40%. A second round of standards, known as Tier 2 standards, would further reduce emissions by 50% from 2003 to 2006, unless an EPA review found that these more stringent standards were infeasible or unnecessary (NESCAUM 2000). This potential flexibility in the Tier 2 standards resulted from a compromise measure to appease those concerned about the impacts of the legislation on the automobile industry; by providing a future opportunity to resist the most stringent standards the legislation was more acceptable.

During the debate surrounding the 1990 CAAA standards, the automobile industry once again pointed out the uncertainties that the technology required to meet the emission standards being considered could be developed and implemented (Anonymous 2004). Claims of infeasibility were made although the Tier 1 standards were already being met successfully in California cars. The industry also predicted other negative consequences of making the technical changes necessary to meet the new standards, including reduced fuel economy, higher costs to consumers, reduced drivability, and more recalls (Doyle 2000). The costs associated with the new standards, they argued, were far greater than the associated benefits. Although claims of shutdown of the industry if the standards were upheld like those used in the 1970s were not made, the industry predicted job losses and an economic downturn would result from the strict standards (NESCAUM 2000).

Unlike the 1970 and 1977 CAAA, the 1990 amendments were a high priority for the President; President Bush, after having declared himself the environmental president, was determined to reinforce the nation's air pollution laws (Cohen 1995). In this context, the industry's resistant claims were not as effective in influencing the regulation as they had been in the 1970s. Additionally, the familiarity of the industry's resistant claims to similar claims made in the 1970s that did not materialize weakened the industry's legitimacy and associated level of concern about how stricter standards would impact the industry. And again, despite their claims to the contrary before the regulation was in place, the automobile manufacturers have been able to successfully produce and sell cars that are in compliance with Tier 1 and the subsequently determined Tier 2 standards without any major associated negative consequences (Anonymous 2004).

During this most recent time period, a higher level of complexity compared to the 1970s in the regulatory process, the legislation, and the implementation of the legislation compared to the 1970s has diffused the intensity of interactions between the automobile industry and the government. A much larger number of politicians and industry lobbyists were integrally involved in drafting the 1990 legislation, and far more government beaurocrats and industry representatives have had to focus on the implementation of the new legislation (Cohen 1995). This increased complexity has complicated the relationship between the auto industry and the government and minimized the influence of the industry's strategies of resistance on government decision-making.

One prominent example of this complexity is the involvement of the oil industry. In addition to setting stricter national emission standards for automobiles, the 1990 CAAA also mandated changes to fuel used in automobiles to reduce air pollution. The debate on reformulated gasoline and alternative fuels engaged the oil industry rather than the automobile industry, and this involvement of another large, mature industry in the regulatory debate lessened the intensity of the automobile industry's interactions with the government considerably.

This effect of complexity of players limiting the effectiveness of the industry's strategies to resist making changes can be explained in the context of third parties. The oil industry, in this context, can be viewed as a third party that has altered the intense dynamic between the automobile industry and the government. Once again in this most recent time period, third parties have played a critical role in reducing the effectiveness of industry's strategies of resistance.

3 Analysis of Government-Industry Interactions in This Case

3.1 Arguments of Technical Feasibility – A Cycle of Mistrust

Throughout the fifty year history (1955-present) of efforts to reduce automobile emissions, arguments of technical feasibility have recurred. A reinforcing cycle of mistrust associated with technical details in the industry-government relationship has developed encouraging industry to persistently make claims of technical infeasibility. Following an initial 15 years of minimal industry action in reducing automobile emissions from 1955-1969, the U.S. government became skeptical of the sincerity and level of commitment of the industry's efforts to find technical solutions and responded in 1970 by mandating drastic emission reductions that could not be achieved with current technology. The government's setting these stringent standards, an action that has been described as motivated more by political considerations than technical realities (Ingram 1978; Lundqvist 1980), created an intense hostility and perpetuated a cycle of mistrust on technical details between the government and the industry.

The industry, knowing that the government developed the emission standards without confidence in technical feasibility, felt obliged to highlight the uncertainty in feasibility and the strong likelihood that the standards could not be met. Because the industry felt that the government developed the standards without understanding potential technologies, the industry's internal processes, or the costs of implementing changes, the industry has consistently made claims of technical infeasibility often based upon the most extreme, pessimistic possibilities. Increasingly throughout this history, government regulators recognized the industry's tendency to be pessimistic about future technology, so the regulators have come to view industry's perspective on technical feasibility with skepticism and have continued to uphold and enforce standards that the industry has claimed cannot be met. This mutual mistrust still persists today, although due to the familiarity resulting from the longevity of the industry-government relationship both industry and government are now better able to interpret each other's actions and claims, i.e. in the most recent debates the industry's claims of technical infeasibility have not been taken seriously.

An additional factor feeding into this cycle of mistrust is the industry's apparent perception that their public position on technical feasibility must emphasize the technical uncertainties and potential obstacles in order to counteract the overly optimistic claims of technical feasibility being publicized by third parties, including environmental advocacy groups or pollution control technology companies hoping to develop a market for their product (i.e. catalytic converter manufacturers). The industry, predicting that regulators would reconcile differing perceptions of technical feasibility by averaging the most extreme views, has attempted to offset the optimistic claims of others by claiming a position that is as far on the other end of the spectrum of potential feasibility as possible.

Despite this cycle of mistrust and the hostile government-industry relationship, automobile emissions have been reduced immensely. Whether effective pollution control technology could have been developed sooner or more easily with a different, less hostile type of government-industry relationship is debatable.

3.2 Cooperation vs. Competition within the Industry

When the automobile was first implicated as a major contributor to the urban air pollution problem in the early 1950s (Haagen-Smit 1952), the U.S. automobile manufacturers responded by creating an industry-wide, cooperative agreement which eliminated competition among individual firms to develop pollution control technology. This cooperative approach also severely restricted third party inventions through a cross-licensing agreement that specified royalty-free exchange of patents and a formula for sharing the costs of acquiring patents developed outside the industry; by removing incentive for industry consideration of third party inventions, the industry eliminated any potential market for third party innovators. Individual firms signed on to this cooperative agreement because it minimized the risk to them that another firm would gain competitive advantage by being the first to develop commercially viable pollution control technology (DOJ 1971). The following excerpt from the minutes of an April 1955 meeting of the patent Committee of the industry trade group, the Automobile Manufacturers Association (AMA) explains this strategy.

> *"No one company should be in a position to capitalize upon or obtain competitive advantage over the other companies in the industry as a result of its solution to this problem."* (DOJ 1971)

Despite the industry's public declaration that their cooperative program was designed to accelerate technical developments in emissions reduction, the opposite effect, to slow-down technical progress, has been identified as the intended result of the program by evidence collected during a grand jury investigation assessing antitrust collusion allegations against the industry in the late 1960s (DOJ 1971). Following this investigation, an antitrust civil suit alleging 16 years of industry conspiracy to prevent development of pollution control technology was issued; the case was settled by consent decree in which the industry did not admit to any illegal activity but did agree to a series of restrictions prohibiting the exchange of restricted technical information, prohibiting the issuing of joint announcements, and requiring open access to existing patents and technical reports to third parties, those outside the industry (1969).

During this early period of coordinated industry resistance, the emissions problem was perceived by the automobile industry as a management, public relations challenge, rather than a fundamental problem for which a technical solution had to be developed. This perception allowed the industry to successfully resist making changes by controlling the pace of technological development. The industry did slowly implement simple technical solutions in response to public pressure and regulatory threats urging them to develop a technological response to the air pollution problem. One example of this is the industry's installation in 1963 of a simple valve that allowed for recirculation rather than direct release of pollutants from the crankcase; this positive crankcase ventilation (PCV) valve had been used in military vehicles for decades so it was not a new technology, yet the industry presented the development as a result of their diligent efforts to find technical solutions (DOJ 1971). Very different strategies are employed during this period of a cooperative regime than those employed later during the more competitive regime.

3.3 Role of Third Parties

During the early period from 1955-1970 when the federal government had minimal influence over or interaction with the automobile manufacturers, the California state government was addressing the industry's resistance by encouraging the development of pollution control technology through state regulation. Recognizing the industry's slow pace of development and implementation of technological improvements, California passed legislation in 1960 that was designed to stimulate competition within and outside the industry and provide a mechanism for government regulators to review technical information from within and outside the industry. The Motor Vehicle Pollution Control Act (MVPCA) set strict emission standards, a 70% reduction in HC and a 57% reduction in CO, that were to be enforced one year after two satisfactory emission control devices were certified by the state to meet the standards; all new cars would have to install one of the certified devices (California 1960).

In drafting this legislation, California legislators identified and addressed two critical mechanisms with potential to accelerate the pace of emissions control technology development and reduce the effectiveness of the industry's attempts to resist change: 1) the competitive pressure of third-party innovators, and 2) the asymmetry of information between regulators and the industry. The MVPCA was designed to reduce barriers to market entry of those developing pollution control technology external to the automobile industry by creating incentive by ensuring a market for devices certified to meet the standards (CAMVPCB 1965; Krier and Ursin 1977). At this time catalyst technology was a suspected possible technology, so in response to this legislation a period of intense catalytic research began as many catalytic chemists jumped at the opportunity to work toward this exciting potential application of catalytic technology (Lester 1983; Briggs 1984). By requiring a detailed state certification of all devices, the legislation also created a pathway for information sharing; in the certification process the state regulators gained the opportunity to evaluate the potential of different technical approaches developed.

In 1964, when four externally developed devices (three of which were based on catalytic technology) were certified by the state triggering enforcement of the emission standards the following year, the automobile manufacturers revealed to the state their own internally developed technical changes, which consisted of a series of engine modifications rather than catalytic technology. Once the state certified these industry developed engine modifications, the automobile companies each chose to implement their own internally designed approaches rather than implement the externally developed catalytic devices (Krier and Ursin 1977). So although this legislation motivated and encouraged third party inventors, the inventions were excluded from implementation because the potential market was removed once the state certified the industry developed technologies. Nevertheless, the technological progress that was made in the early 1960s by third parties was influential in demonstrating to both the industry and the government the potential of catalytic technology; this potential was incorporated into 1970 federal legislation.

Engineers involved in the development of the catalytic technology have suggested that if cooperative relationships among industry, government and third parties had existed, an effective combination of engine modifications and catalyst systems could have resulted in an efficient pollution control technology that could have surpassed the California standards by the mid-1960s (Briggs 1984). Instead the industry's engine modifications approach with a limited level of reductions prevailed while the catalytic technology with a far greater potential level of reductions was not developed for implementation until the industry had to respond to the more stringent federal regulations issued in 1970.

The critical role of third parties in reducing the effectiveness of industry's resistance to making technical changes is demonstrated in the 1970s also, when the auto manufacturers applied for an extension to the standards set in the 1970 Clean Air Act Amendments (CAAA). To appease industry's concern about the technical feasibility of meeting the strict standards set in the 1970 CAAA, the legislation included two flexibility mechanisms: 1) automakers were allowed to apply for a one-time, one-year extension if they could demonstrate to the Environmental Protection Agency (EPA) administrator that the technology was not yet available, and 2) upholding the standards was contingent on the assessment of technical feasibility to be carried out by the National Academy of Science (NAS). These flexibility mechanisms provided two different avenues for third parties to influence the industry-government dialogue.

During the extension hearings the testimony of independent companies developing pollution control technology influenced both the industry and the government. Independent suppliers of catalytic converters (the primary technology considered capable of meeting the standards), provided manufacturer-conflicting testimony to federal regulators about the feasibility of implementing the new technology during the 1972 and 1973 hearings to consider whether or not the industry deserved an extension to meet the standards (EPA 1972). Additionally, technological developments made by several non-U.S. auto manufacturers provided regulators with a more optimistic perspective on the technological possibilities of reducing emissions than the one promoted by the U.S. automakers. Specifically Honda developed an alternative engine design (a stratified charge engine) that could meet the 1975 standards without a catalytic converter (Abernathy and Ronan 1978). Although initially the EPA denied the industry's request for an extension in 1972, the U.S. court of Appeals ordered the EPA to reconsider the automakers' request in 1973 and this time the one-year extension was granted.

4. Conclusions

The details of this case suggest that the only time a firm has an interest in explicitly stating that an ambitious environmental performance goal is feasible is when they want to sell the technology required to achieve the goal e.g., Honda's CVCC engine, and Engelhard, the catalytic converter company that provided testimony to EPA on the feasibility of catalytic converters in 1972. For other firms, the strategic choice is between aggressive claims of infeasibility to oppose a proposed regulation, and passive acceptance. This choice is probably subject to a tipping point, by which it becomes disadvantageous to continue claiming infeasibility when either a) enough technological information has been revealed that the claims pass from appearing reasonably cautious to appearing dishonest and obstructionist, or; b) political forces behind a proposed regulation have become strong enough that there is no reasonable probability of infeasibility claims succeeding in stopping it. Better recognition by policymakers of these incentives and disincentives associated with admitting or denying technical feasibility of meeting a regulation could allow for improved communication between government and industry.

This case also provides useful insight on the potential role of industry cooperation. If the purpose of a cooperative body is principally to let firms monitor each other's efforts and announcements, its effect is likely to be to suppress rather than facilitate innovation even if they don't (as the automakers did) have explicit agreements to discourage efforts. Government or outside independent expert participation in cooperative bodies is probably a sufficient guarantee against such uses of cooperative bodies. If the threat of a required environmental performance target is credible, the cost of failing to meet it is high enough, the collective interest of the industry is to meet it, and there's only potential benefit, no harm, in facilitating cooperative work toward it, a cooperative effort may also be productive. Additionally, for some industries, more fragmented industries with lots of smaller firms with less R&D capacity in each firm, cooperative bodies may provide crucial increments of technical capacity to solve environmental problems

Additionally, this case has demonstrated in several different ways the critical role that third parties can play in facilitating more productive interactions with regard to technical details in government-industry interactions. The asymmetry in access to technical information between industry and government (regulators often rely on technical information provided to them by the industry because independent technical information is limited or non-existent) can be minimized by the active involvement of third parties. Third parties need to be encouraged to reveal information about capabilities without jeopardizing their commercial relationships.

Finally this research demonstrates the dynamic, interactive nature of the relationship between industries and governments; these interactions should not be overlooked in considerations of how best to create incentives for industry development and implementation of environmental regulations.

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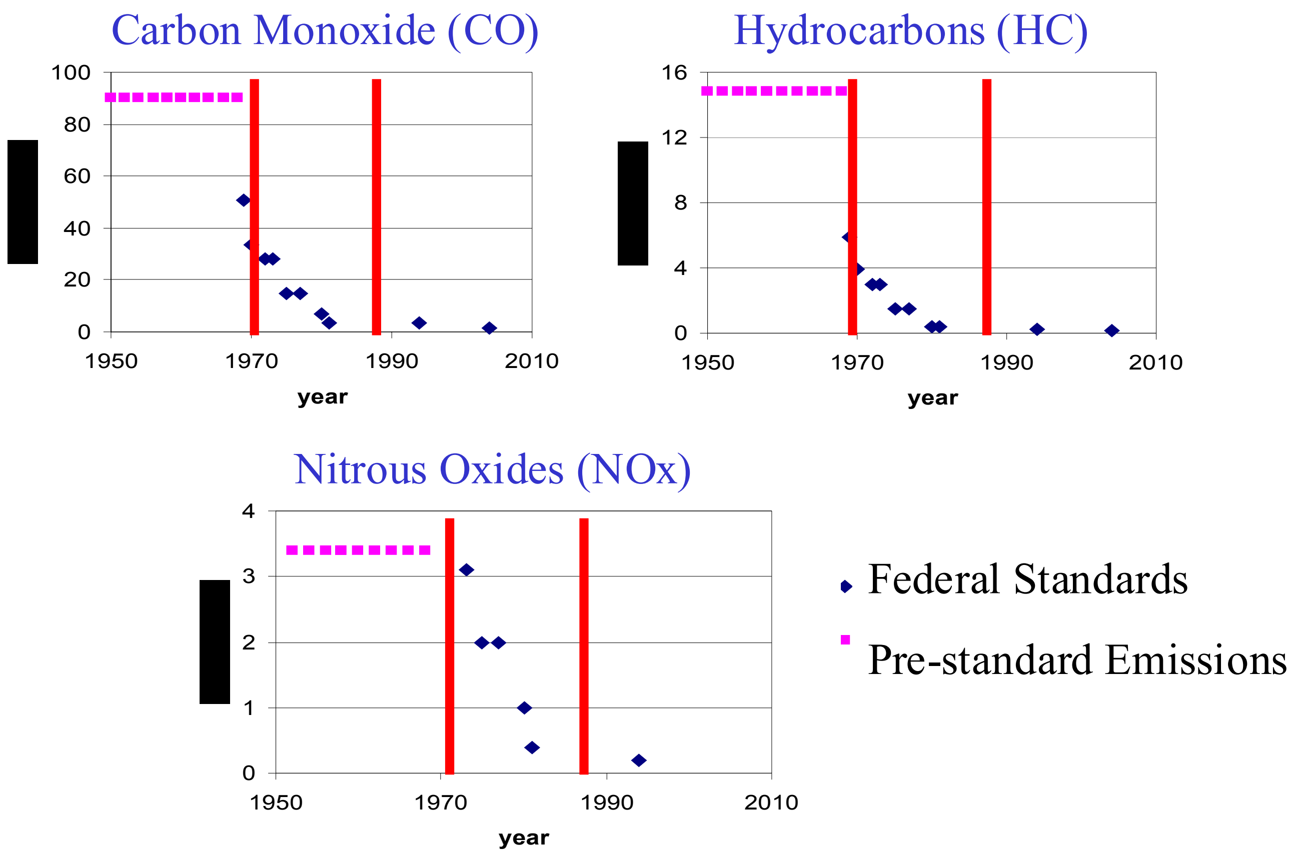


Figure 1. These graphs demonstrating the pre-standard emissions and the decreasing federal standards for the three primary automobile pollutants, carbon monoxide (CO), hydrocarbons (HC), and nitrous oxides (NOx) also show how the fifty-year history can be divided into the three distinct time periods described in the text.

Comments on
"A Multi-Agent Model of a Small Firm"

by

Carl Pasurka*

for

EPA workshop on
"Corporate Environmental Behavior and the Effectiveness of Government Interventions"

Washington, DC

April 26, 2004

*Any errors, opinions or conclusions are those of the author and should not be attributed to the U.S. Environmental Protection Agency.

This study investigated interpersonal dynamics that influence corporate environmental behavior. In its present form, most of the study is not relevant to the U.S. EPA. This study focuses on: (1) an overview of networks and organizations, (2) a survey of the plastics industry in New Jersey, (3) a case study of three companies, and (4) a simulation. This study claims that its ability to analyze (1) eco–parks and (2) industrial ecosystems will make it relevant to the U.S. EPA.

I will focus my comments on those sections with economics content. In the "Industry Background" section, the study employs 2001 data. Currently, 2002 data are available from The Society of the Plastics Industry (SPI). While 2002 data reveal that employment and shipments declined by approximately 10 percent between 2001 and 2002 for New Jersey, it remains among the top ten states in shipments of plastics (source: The Society of the Plastics Industry http://www.plasticsdatasource.org/facts/nj.pdf)

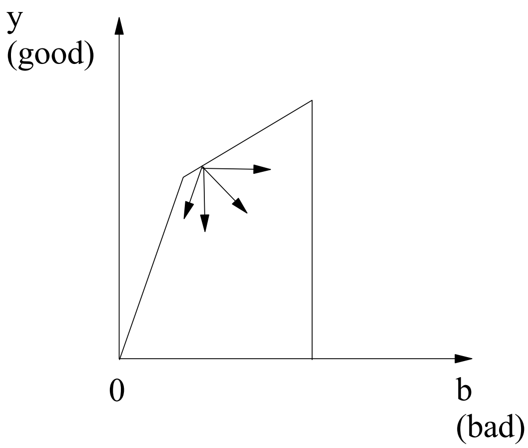
Another data issue is the discrepancy among data sources with regard to the size of the plastics industry in New Jersey. The following table shows the employment and value of shipments for plants included in NAICS codes 3259 and 3261 for New Jersey according to the 2001 *Annual Survey of Manufactures* and the Society of the Plastics Industry (SPI):

	Annual Survey of Manufactures	SPI
Employment	36,371	51,011
Shipments	$6.4 billion	$11.7 billion

Source: U.S. Census Bureau http://www.census.gov/mcd/asmdata/2001/nj34.htm

In the section "Illustrative Result - Bringing in Worker Error," the study concludes that firms with imperfect employees are less profitable and pollutes more. My initial interpretation of this statement is that worker error is a source of technical inefficiency (i.e., firm produces inside its production possibilities frontier). Hence, inefficiency manifests itself in the form of reduced good output production and increased bad output production.

However, there are several possible definitions of increased technical inefficiency. One definition is a proportional contraction of good outputs and expansion of bad outputs. Additional definitions involve contraction of good (bad) outputs while maintaining original level of production of bad (good) outputs. Finally, technical inefficiency can reveal itself as a proportional contraction of good and bad outputs. These different definitions of technical inefficiency are illustrated in the following diagram:



Joint Production Frontier

I wish to submit several questions/recommendations to the author. First, how are the results of this study relevant to analyses of eco-parks and industrial ecosystems? Second, the underlying economic assumptions of simulation model should be made more transparent. Most important, the study contained no explanation of the production technology. For example, if an imperfect worker mistakenly turns off pollution control equipment, why would the firm be less profitable? Finally, is worker error a justification for firm over compliance in order to avoid violations of regulations?

Comments on
"Compliance and Beyond: Strategic Government- Industry Interactions in Environmental Policy and Performance"

by

Carl Pasurka*

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This study focuses on the role of knowledge, uncertainty and arguments about perceptions of technical feasibility in the development of environmental policy. Environmental policy seeks to reduce emissions (i.e., bad outputs) which are the undesirable by-products of a society's production and consumption activities. The study investigates issues associated with the design of regulations that encourage technical change which incorporates environmental improvement. Regulations change the mix of good and bad outputs produced which influences the direction of technical change. A key question is what is the extent of this regulatory induced technical change?

Several definitions of technical change may be employed when discussing cases when both good and bad outputs are produced. One definition is a proportional expansion of good and bad outputs. A second definition of technical change involves expansion of good output production while maintaining the original level of bad output production. The third definition of technical change, which is most relevant for this study, involves a proportional expansion of good output production and contraction of bad output production.

The focus of this study is the development of regulations on motor vehicle emissions. Economists have experienced great difficulty in assessing the costs of pollution abatement activities associated with motor vehicles. This was shown by the discrepancy between EPA and Bureau of Economic Analysis estimates of pollution abatement costs associated with motor vehicles. This provides some indication of the difficulty of assessing the cost of implementing regulations and may provide an indication of the difficulty of assessing the technical feasibility of new technologies for reducing automobile emissions.

I had several questions for the authors. Would this study reach different conclusions if it were analyzing the interaction between the auto industry and regulators for other regulations? For example, what has been the relationship between the auto industry and government regulators during the implementation of regulations associated with sea belts, air bags, and Corporate Average Fuel Economy (CAFE) standards?

Is the discussion about the role of (1) third parties and (2) cooperation in R&D efforts in industries with smaller firms relevant to the environmental R&D efforts of other industries?

Are the conclusions of this study relevant to extant literature? This includes the literature on asymmetric information between regulators and industry, and the role of monitoring and enforcement activities. Several articles that appeared in the *Journal of Environmental Economics and Management* may be relevant to this study:

Hackett, Steven (1995) "Pollution-Controlling Innovation in Oligopolistic Industries: Some Comparisons between Patent Races and Research Joint Ventures," *Journal of Environmental Economics and Management*, 29, No. 3 (November), 339-356.

Stafford, Sarah (2002), "The Effect of Punishment on Firm Compliance with Hazardous Waste Regulations," *Journal of Environmental Economics and Management*, 44, No. 2 (September), 290-308.

Brunnermeier, Smita and Mark Cohen (2003), " Determinants of Environmental Innovation in US manufacturing Industries," *Journal of Environmental Economics and Management*, 45, No.2 (March), 278-293.

Comments on
"Do Facilities with Distant Headquarters Pollute More?: How Civic Engagement Conditions the Environmental Performance of Absentee Managed Plants"

by

Carl Pasurka*

for

EPA workshop on
"Corporate Environmental Behavior and the Effectiveness of Government Interventions"

Washington, DC

April 26, 2004

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This study addresses the question of whether the extent of civic engagement affects the environmental performance of plants operated by absentee managers? Toxic Release Inventory (TRI) data are used as a proxy for the environmental performance of plants. The TRI data are collected under the Emergency Planning and Community Right-to-Know Act and are self-reported data. Mary Streitweiser (1994) found substantial variation in emission intensities of 3-digit SIC industries within the chemical industry in 1987. These results are shown in the table accompanying these comments.

The author employs regression analysis to determine which factors are associated with TRI emissions of chemical plants. In this study, the quantity of TRI emissions from a plant is its measure of environmental performance. However, two factors affect the quantity of emissions: (1) its emission intensity (i.e., bad output production per unit of good output production) and (2) its scale of operation (size of plant). Hence, a plant can emit relative small quantities of toxic emissions per dollar of output but emit a relative large quantity of toxic emissions if it is a large plant.

After reading this study, I have several questions for the author. Does civic engagement affect a plant's emission intensity or scale of operation? The emission intensity of a plant may be determined by technology over which local managers may have little or no control. Is a plant's scale of operation affected by a community's attitude? Does civic engagement affect what type of plant is located in a community?

What is the effect of plant age on emissions? Do newer plants employ technologies that produce less pollution per unit of good output production than older plants?

Would regional/state dummy variable explain some of the differences in plant TRI emissions among states/regions?

Different communities seem to have different views about companies with external managers. Are absentee managers imposed on communities or are they actively pursued by communities? While there is a recent example of a California community resisting the construction of a new Wal-Mart, there are other examples of communities using tax incentives to influence the plant location decisions of companies.

Is the existing economics literature relevant to this study? For example, is there a link between findings of this study and economics literature on factors affecting plant location decisions? In addition, this study found that race and class characteristics of a neighborhood are unrelated to emissions. This is a topic that has been of interest to some economists

Is there a link between the findings of this study and economics literature on TRI? For example:

Henriques and Sadorsky (1996), "The Determinants of an Environmentally Responsive Firm: An Empirical Approach, " *Journal of Environmental Economics and Management*, 30 , No. 3

(May), 381-395.

Konar, Shameek and Mark Cohen 91997), "Information As Regulation: The Effect of Community Right to Know Laws on Toxic Emissions," *Journal of Environmental Economics and Management*, 32, No. 1 (January), 109-124.

Brooks, Nancy and Rajiv Sethi (1997), " The Distribution of Pollution: Community Characteristics and Exposure to Air Toxics," *Journal of Environmental Economics and Management*, 32, No. 2 (February), 233-250.

Khanna, Madhu, Wilma Quimio, and Doa Bojilova (1998), "Toxics Release Information: A Policy Tool for Environmental Protection," *Journal of Environmental Economics and Management*, 36, No. 3 (November), 243-266.

Khanna, Madhu and Lisa Damon (1999), "EPA's Voluntary 33/50 Program: Impact on Toxic Releases and Economic Performance of Firms," *Journal of Environmental Economics and Management*, 37, No. 1 (January), 1-25.

	Sum Toxic Releases[1]	Mean Toxic Intensity[2]	Standard Deviation	Coefficient of Variation	Interquartile Range
Chemicals & Allied Products (28)	2,794.27	19.03	89.17	4.69	8.06
Industrial Inorganic (281)	360.09	34.07	172.30	5.06	7.21
Plastics & Resins (282)	441.41	11.30	35.07	3.10	7.22
Drugs (283)	85.23	13.73	33.09	2.41	8.26
Soaps & Cosmetics (284)	25.75	3.22	11.86	3.68	0.85
Paints & Allied Products (285)	65.05	9.15	27.14	2.97	7.49
Industrial Organics (286)	1,106.63	34.50	110.04	3.19	22.09
Agricultural Chemicals (287)	649.19	50.45	135.99	2.70	22.58

Misc. Chemicals (289)	60.93	7.48	35.08	4.69	4.07

[1]pounds of toxins releases and transfers (in millions)
[2]pounds of toxins / $1000 value of production

Source:
Streitwieser, Mary (1994), "Cross Sectional Variation In Toxic Waste Releases From The U.S. Chemical Industry," Center for Economic Studies, Working Paper CES-WP-94-8
http://148.129.75.160/ces.php/abstract?paper=100230

Discussant's Comments on Papers in the Session on "Approaches to Environmental Performance" at the EPA Conference on "Corporate Environmental Behavior and the Effectiveness of Government Interventions"

April 26, 2004

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The purpose of this report is to provide feedback to authors of the three papers presented in the session on "Approaches to Environmental Performance." These studies are quite diverse, in terms of their theoretical perspectives and empirical methods, as well as the disciplinary backgrounds of the authors. As my comments will reveal, they are also at different stages of development. I begin with the paper that is closest to a "final product."

Paper #1: Do Facilities with Distant Headquarters Pollute More? How Civic Engagement Conditions the Environment Performance of Absentee Managed Plants

This lucid and insightful paper is an econometric analysis of the determinants of the environmental performance of chemical plants. A major contribution of this study is its attempt to link several indicators of "civic engagement" to the propensity of absentee managed plants to emit chemical toxins. A key finding is that absentee managed plants tend to have better environmental performance when they are located in communities where there is more civic engagement.

I have two theoretical concerns. The author should reflect on several recent papers that analyze incentives firms have to be environmental socially responsible (henceforth, ESR). For example, McWilliams and Siegel (2001) outline a theory of the firm/supply and demand perspective on ESR. Their model assumes that firms weigh the costs and benefits of engaging in this activity. Some of these benefits include a greater ability to differentiate products, enhance the firm's reputation/image, and build or sustain good relations with key stakeholders (e.g., employees, government, and investors). In sum, firms are responding to growing demand from various stakeholders, including consumers, employees, and portfolio managers representing social investors, who examine pollution measures such as the TRI in their overall assessment of firm environmental performance.

The McWilliams and Siegel framework suggests that ESR is an integral part of a firm's corporate and business-level strategies. More specifically, the authors conjecture that the propensity of firms to engage in ESR is positively correlated with firm size (a variable Professor Grant includes in his empirical analysis), scope of activities, R&D, and consumer income/wealth. That is, larger, more diverse, and more technologically advanced firms derive greater benefits from engaging in ESR. Information asymmetry between firms and consumers (and other stakeholders) regarding the social desirability of managerial practices also appears to play a critical role in determining the incidence of CSR. In a previous paper (McWilliams and Siegel (2000)), the authors report empirical evidence that is consistent with a theory of firm perspective. That is, they find a strong positive correlation between the social performance of firms and the rate at which they invest in R&D and advertising. Another key paper in this area is a study by Russo and Fouts (1997), who outline a "resource-based view" of ESR. The authors hypothesize that ESR can constitute a resource that generates a competitive advantage. They confirm this hypothesis using extensive data on environmental and firm performance.

The agency theory perspective also bears mentioning in this context. Agency theory is based on the principal agent framework. An example of a principal/agent relationship concerns shareholders, who own the firm (and thus, are the principals) and the CEO and senior management, who are the agents of shareholders. It is well known that agents (managers) often pursue policies that are not in the best interest of principals (shareholders). This leads to what is referred to in the literature as "agency costs," or costs associated with insufficient effort by employees and administrative costs associated with policies to deter such slack effort. In this context, agency costs may be relevant when senior management at corporate headquarters is overseeing the environmental performance of numerous manufacturing plants.

My point is that there may be diseconomies of scope in monitoring the environmental performance of many establishments, perhaps because managerial resources are spread too thin. The literature (see Jensen (1993)) also suggests that agency problems may be more severe for large, diverse, publicly-traded firms, where is there typically greater separation of ownership and control. Thus, at minimum, it might be useful to include a dummy as a right-hand-side variable in the econometric analysis denoting whether shares of the corporate parent of the plant are publicly traded. Note also that our previous discussion in this section on the strategic use of ESR strongly suggests that the "returns" to ESR may also be higher for publicly-traded firms.

I also have several comments relating to measurement issues and the econometric analysis. The author estimates the following equation:

$$\text{(1)}\quad \mathbf{ENVPERF = f\,(ABSENT,} \sum_{i=1}^{I} \beta_i\, \mathbf{CIVENG,} \sum_{j=1}^{J} \delta_j \mathbf{DEMO,}$$

$$\mathbf{PLANT,\ FIRM,\ IND)} + u_i$$

where the environmental performance (ENVPERF) of the plant is presumed to be a function of a dummy variable denoting whether the plant has an "absentee owner" (ABSENT), a vector of indicators of "civic engagement" (CIVENG), several demographic factors (DEMO), including race and class, plant and firm characteristics (PLANT, FIRM), and a few sub-industry dummies (IND).

It is important to note that there are several econometric concerns regarding OLS or simple random effects estimation of equation (1). These concerns are measurement error and specification error, which could result in biased, inconsistent, and inefficient parameter estimates. The first issue is measurement error in the dependent variable. Note that we don't observe the plant's "true" environmental performance (ENVPERF*), but rather an imperfect, self-reported indicator based on the toxic release inventory (TRI) data:

$$ENVPERF = ENVPERF^{*} + \varepsilon$$

where ε is the measurement error. As we know from basic econometric theory, errors of measurement in a dependent variable yield unbiased, although inefficient estimates if these errors are uncorrelated with the independent variables. Thus, the following assumptions must hold. Cov (ε, ABSENT)=0; Cov(ε, CIVENG)=0;

However, I conjecture these assumptions could be invalid, since plants with absentee owners and those that are located in communities where there is more "civically engagement" may have an incentive to overstate their environmental performance. In the former case, overstatement could arise because of the monitoring problems noted earlier. In the latter case, overstatement might result from managers being aware of the fact that communities with greater civic engagement will expect to see superior environmental performance in local manufacturing facilities. Alternatively, managers may believe that tightly knit communities will actively oppose the facility if they perceive that the plant is inflicting environmental damage on the community.

Some additional measurement problems should also be addressed. The measure of absent ownership is a dummy variable denoting whether the plant's corporate headquarters is located in the same state as the facility. A better measure would be based on the distance between the plant and its corporate headquarters. I am also a bit concerned about the fact that "civic engagement" is a rather fuzzy construct. Thus, further justification of these measures is needed or the author may choose to employ an econometric method that attempts to control for such measurement error.

Another econometric concern is specification error, in this case a key omitted variable-R&D. McWilliams & Siegel (2000) have shown that R&D is positively correlated with corporate social and environmental performance, as well as firm size (an included regressorin Professor Grant's model). I am also concerned about possible "Schumpeterian" effects. Joseph Schumpeter, the eminent Harvard economist, asserted that larger and more diverse firms have a greater propensity to engage in innovative activity than small firms. He also argued that such companies reap higher returns to R&D than small firms. There is some empirical evidence of Schumpeterian effects in the chemical industry (see Link (1980) and Mansfield (1980)). In his excellent book, Scott (2003) presents an economic analysis of new primary data on environmental research in the chemical industry and reports evidence that is consistent with previous Schumpeterian findings.

There are several possible "solutions" to the measurement/econometric problems I have identified. The first is instrumental variables estimation (e.g., 2SLS, 3SLS) or some form of systems equations estimation (Griliches (1986)). Another approach is multivariate reverse regressions, which can be used to derive bounds on the extent of the impact of the measurement error on the parameter estimates. I believe that the best approach would be a "multi-indicators, multiple-causes" (MIMIC) model, a type of LISREL model, in which you would attempt to "explain" the measurement error (see Siegel (1997)). A MIMIC model is essentially a full-information version of instrumental variables. These models have been used in numerous sociological studies.

<u>Paper #2 "Compliance and Beyond: Strategic Government-Industry Interactions in</u>

Environmental Policy and Performance”

This paper seeks to advance our understanding of how firms react to the threat of regulation. According to the authors, they have several options. They can attempt to oppose, influence, delay, or support such initiatives. The authors wish to analyze these strategies. On the other side of the equation, they also wish to examine how regulatory agencies react to such efforts. I presume that the ultimate objective is to design better policy initiatives that take account of strategic interaction s between firms and regulatory agencies.

I have several concerns with the current version of the paper. The first is that there is a major disconnect between the title and the text. The papers reports findings from a single case study. I am also a bit unclear about whether this is supposed to be an exercise in grounded theory development. If this is true, the authors need to explain why this approach is warranted in this context. After reading the introduction, I thought that the authors would propose to develop a taxonomy of strategies employed by firms and public agencies. Alas, such a taxonomy was not considered in the remainder of the manuscript. I would like to encourage the authors to move in this direction, since this would be a really useful outcome.

The paper would also greatly benefit from additional discussion/consideration of economic theories of regulation. “Capture” theories of regulation are of course highly relevant in this context. These refer to instances when regulatory agencies are “captured” by the firms they are supposed to control. In his seminal paper, Stigler (1971) argued that firms will actually lobby for additional regulation when such legislative initiatives yield either direct monetary subsidies to these corporations, impose constraints on substitute products or subsidies on complementary products, create conditions that make it easier for incumbent firms to fix prices or collude along some other dimension of competition, and when it enhances the ability of incumbent firms to control entry.

The authors should also consider the tension between corporate social responsibility (CSR) and regulation (Siegel (2001), McWilliams and Siegel (2002)). My point is that there is a possibility that CSR could be used to forestall regulation. Pre-emptive CSR strategies should also be considered. That is, it is conceivable that CSR (and regulation) can be used a means of raising rivals' costs. Marvel (1977) demonstrated the strategic use of CSR in the British textile industry in the early 1800s. The bottom line is that a polluting firm might actively seek additional environmental regulation if this would raise rivals' costs more than its own.

Another important trend needs to be considered: the growth of "strategic research partnerships (SRPs). An SRP is defined as any cooperative relationship involving organizations that conduct or sponsor R&D. The end result is that R&D is increasingly a collaborative activity. The increase in SRPs can be attributed to the following policy changes: an expansion of public -private partnerships, explicit relaxation of antitrust enforcement to promote collaborative research (e.g., the National Cooperative Research Act (NCRA) of 1984), and policies promoting more rapid technological diffusion from universities to firms (e.g., the Bayh-Dole Act of 1980). Examples of partnerships involving private firms only are strategic alliances/networks, licensing agreements, research joint ventures (RJVs), and industry consortia (SEMATECH). Examples of public-private SRPs include co-operative R&D Agreements (CRADAs) between federal laboratories and firms, NSF Industry-University Co-operative Research Centers (IUCRCs) and Engineering Research Centers (ERCs), university licensing, sponsored research agreements, and entrepreneurial startups, and publicly-funded R&D programs such as the U.S. Commerce Department's Advanced Technology Program (ATP).

The authors mention the role of "third parties." I would like them to consider two additional players: activists/NGOs and social investors. Baron (2001) and Fedderson and Gilligan (2001) assert that activists and NGOs may play a vital role in reducing information asymmetry between firms and consumers regarding the "social desirability" of a firm's managerial practices. Social investors and ethical funds could also be key financial stakeholders in certain industries. This highlights the importance of firms that attempt to measure the social performance of companies for portfolio managers of "screened" mutual funds and other social investors (e.g., Kinder, Lydenberg, and Domini).

Paper #3 ""A Multi-Agent Model of A Small Firm"

I would like to begin with some words of praise. The authors deserve a great deal of credit for mixing quantitative and qualitative methods. That is highly unusual in the social sciences and in my view, an approach that is ideal for an interdisciplinary topic such as corporate environmental.

This paper addresses a wide range of organizational issues, including questions that are unrelated to environmental activity. I encourage the authors to ask a smaller set of clearly-defined research questions that are more targeted to environmental issues. In the next version of the paper, the authors need to provide much more information on the qualitative methods and techniques employed. As far as I can tell, you interviewed only one person from each firm. I could be wrong about this, but this is not clear in the text. You should add a separate section on this issue and have a chart or table presenting the set of questions you asked these managers. I am also concerned about your small and possibly biased sample: four firms in a single industry (plastics) in a single state (New Jersey). You need to include more material to convince the reader that this industry is somehow representative of manufacturing industries and worthy of attention.

I would also like to see a more structured approach to the qualitative work. As outlined in Miles and Huberman (1994), there are techniques that can be employed to quantify the qualitative data from the structured interviews. This involves a detailed analysis of the interview transcripts, often using a software package such as Nudist. The first stage of analysis is data reduction, or the identification of themes that emerge from the interviews. The second stage is data display, or the generation of frequency counts of the number of times a particular theme is mentioned. The quantitative results can be used to draw conclusions from the interview transcripts (See Siegel, Waldman, and Link (2003) for an example of this approach).

As far as I can tell, the method used to identify social networks is quite crude. Nahapiet and Ghoshal (1998) and (Gant, Ichniowski, and Shaw (2002) present more sophisticated ways of conceptualizing and measuring the incidence and effects of social networks. For example, Nahapiet and Ghoshal (AMR-1998) identify three dimensions of social capital. The first is the structural aspect, which refers to the configuration of ties/relationships that emerge in the network. Another dimension is the relational aspect, which describes the nature of the relationships that people have developed with each other. Finally, there is the cognitive aspect, which refers to resources that provide shared representations, interpretations, and systems of meaning among the various actors in the network.

My final concern relates to the simulation model. It is well known that such models are highly sensitive to assumptions researchers make regarding key parameter values. Thus, it is incumbent upon the authors to present a clear statement of the assumptions of the simulation model. Given the importance of this concern, I believe it would be best to include this information on a separate chart or table.

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Organizational Practices on the Productivity of University Technology Transfer Offices: An Exploratory Study," *Research Policy*, Vol. 32, No. 1, pp. 27-48 (A previous version of this paper appeared as NBER Working Paper #7256, July 1999).

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Summary of the Q&A Discussion Following Session III

Magali Delmas (U.C. Santa Barbara)
Directing her comments to Dr. Grant, Dr. Delmas stated that she "really likes the idea of actually looking at the firm characteristics and the plant characteristics and looking at how community pressure can impact environmental performance and how these firm characteristics mitigate this." However, she said she wondered whether headquarter location is the right measure and went on to provide some feedback from her current research into "how environmental measures at the city level respond to stakeholder pressure." She said she has received conflicting opinions from those she has interviewed, with some saying that the main action stakeholder is the corporate headquarters and others saying, "No, it's the community, and it doesn't relate to the location of the headquarters." So, this has led her to wonder "what type of other measures [could be used] to tease out whether this is kind of a centralized type of management, with everything kind of done at a corporate level, or whether it's more decentralized, with the city or the plant actually having some decision-making power.

Dr. Delmas added, however, that they found that "headquarters location *matters* in terms of adopting environmental management practices," and she said cities where headquarters are located more commonly implement environmental management practices.

Don Grant (University of Arizona)
Dr. Grant responded, "This kind of goes back to Carl's [Carl Pasurka, one of the discussants] first attack [laughter] about how you go about measuring absentee management plants," and he agreed with Dr. Pasurka that in a lot of the current economic geography literature the standard policy is to measure in terms of miles between a plant and its headquarters. He went on to explain that the reason he chose to measure in terms of whether a plant is headquartered in the same state was "because of all the covenants beginning in the early 1980's . . . when states were competing for businesses and they were trying to lure them by lowering their environmental standards." Acknowledging that the other method might work as well, he concluded by saying, "Those are the only two alternatives I've ever come across. If there's a better one, let me know.

Andrew Hutson (University of North Carolina, Chapel Hill)
Addressing Dr. Grant also, Dr. Hutson said, "You've embedded your argument in the larger globalization debate, and I'm wondering if the data you use aren't more appropriate simply just for looking at different regional variations within the United States. Citing the different dynamics that come into play on a global scale—e.g., regulatory dynamics, administrative capacity, community pressures (with people being better organized)—and the fact that multi-national firms "may have different and better incentives [than smaller, local firms] to have structured, formal environmental management in place," Dr. Hutson questioned the "generalizability" of Dr. Grant's findings for the larger, global debate in which he embedded his work.

Don Grant
Dr. Grant responded that he had been "*very* careful not to suggest" that his findings could be generalized and applied to other situations in the world. He stated that the reason he couched his argument in terms of the globalization debate is "that's how it's typically addressed *today*," as opposed to 50 years ago when it was more of a domestic issue. He added that he believes that the most relevant literature is the literature that has to do with domestic plant growth and re-location.

Going on, Dr. Grant stated, "By the same token, I wanted to suggest in the paper that there are future avenues of research" and once more studies have produced more data, he will then be able to test the generalizability of his study. He agreed with Dr. Hutson that at the present time it's important to stress that studies that have uncovered the absentee management effect are limited to the U.S. He concluded by adding that they had looked at the effects of foreign-owned firms on environmental performance—an issue particularly relevant to the chemical industry because so many of those firms *are* foreign-owned—and they found no evidence that foreign ownership "has a bad effect on emissions."

Wayne Gray (Clark University)
Dr. Gray addressed his comments to Dr. Grant, also, and said he was "just a bit concerned" that Dr. Grant was getting his comparisons between locally managed and absentee-managed plants from *within* the chemical industry, which isn't necessarily a very homogeneous group. As Dr. Gray put it, "There are a lot of different sub-industries within chemicals and such" and, depending on the product being produced, some of those might be inherently more likely to be absentee-managed. He gave the example of products that have high transportation costs. A firm producing such a product would be more likely to have production facilities "spread all over the country" and necessarily absentee-managed, whereas other products that are more easily shipped might be more centrally produced. Dr. Gray wondered whether that factor was "correlated with any sort of sensitivity in terms of how easy it is for them to reduce their pollution." He wasn't sure how much or what kinds of controls had been used in the study "in terms of the particular kind of products, either . . . controlling for the 4-digit industry or something like that *or* the interaction effect with the local community."

Don Grant
Dr. Grant admitted that they haven't explored that in great detail, but agreed that there is much heterogeneity within the industry. He added the example of continuous-processing plants and batch-processing plants (e.g., soaps and detergents) and said that issues such as these might have implications for how far a facility can be from the corporate headquarters. He closed by saying, "We really haven't delved into these sub-industry differences, but I think there could be something there."

Irene Xiarchos (West Virginia University)

Returning to the issue of the distance factor, Ms. Xiarchos asked Dr. Siegel why one would want to measure "the exact distance of the headquarters from the location where the product is produced."

Don Siegel (Rensselaer Polytechnic Institute)
Dr. Siegel responded by clarifying that the argument in question is that "the farther away the senior managers and corporate headquarters were, the more likely they were to be disengaged from what was going on at the plant." He presented the example of himself, living in Albany, New York, ten or fifteen miles from the Massachusetts border, yet 500 miles away from Buffalo, which is in the same state. He believes categorizing by distance provides a much more precise picture of an area of influence.

Irene Xiarchos
Ms. Xiarchos countered that "rather than looking at distance specifically," maybe going by geographic/political levels or boundaries—county, state, region, country, continent—would yield a more meaningful stratification. She reiterated that she didn't "think the distance measured in kilometers would necessarily make a difference."

Don Grant (University of Arizona)
"It's a great empirical question. Again, the reason why I studied it as we did was because in the context of environmental regulation, states matter, and so the state boundaries are factored into our absentee management."

Pete Andrews (University of North Carolina, Chapel Hill)
"I'd really like to hear Clinton Andrews respond to some of the comments that were made about his paper, because having not read the paper but listening to the presentation, I'm really *intrigued* by the *potential* of this area, but the comment is also correct that it is very unspecified in terms of the actual presentation."

Clinton Andrews (Rutgers University)
Dr. Andrews acknowledged that in a half-hour presentation that includes "empirical stuff plus some modeling results, there's not much time to go into the details," but said he would gladly present more details to anyone with the time and inclination to gather around his laptop computer. He went on to say that he *did* feel compelled to clear up the discussion of worker error, and he explained: "The way we did it, which is just one way among many of conceptualizing it, was that workers had to interact with their technology and basically adjust it. The technology had optimal set points, and the workers would basically err in hitting those set points. . . . When it's structured that way, then you inevitably find that profits are going to go down and pollution is going to go up because of the form of that particular technology and the production function."

Rob Axtell (Brookings Institute)
Dr. Axtell followed up on Professor Siegel's comments on Dr. Grant's paper, his concern being primarily the re-writing of the model as a locational choice model—in other words,

taking a free-choice model and adding local structures to that. He said this can potentially present a problem because "when you think about it, normally the emissions level would depend on the civic engagement variable. But it could also be the case that the civic engagement level is in fact dependent on the level of emissions in some important way." He just wanted to reiterate that this is a difficult econometric and specification problem.

Don Siegel

Dr. Siegel responded by saying, "I don't think you can address that problem with cross-sectional data. If you had panel data . . . and you could add some data over time, you could probably do that."

END OF SESSION III Q & A