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Environmental Performance and the Market for Corporate Assets

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Research summary*: Scholars and policy-makers have tended to assume that asset sales have a negative effect on stakeholders, but quantitative evidence to inform the debate has been scarce. In our research, we explored one way such sales could be beneficial: by facilitating the transfer of specialized capabilities used for environmental improvement. Employing quantitative data from a longitudinal sample of U.S. manufacturers, we find evidence consistent with the transfer of capabilities to or from acquired assets. Our results inform theories of ownership change and the conditional flow of capabilities among operations. They provide evidence as well of the existence of environmental capabilities. For policy-makers they provide needed evidence and insight on the merits of regulations designed to limit asset sales.*

Managerial summary*: It is often assumed that acquisitions harm environmental performance--acquisition leads to greater emphasis on efficiency, while focusing on environmental performance is driven by managerial discretion. We propose instead that acquisitions might lead to improvement in environmental outcomes; the key is in knowing where to look for improvement. We studied thousands of facility-level acquisitions and find that when a clean firm buys a facility from a dirtier firm, that facility's environmental performance improved. When a dirtier firm buys from a cleaner one, however, it is the dirtier firm's other facilities in the same industry of the target that improved. These results, along with extensions we undertook, suggest that managers and policy-makers should view acquisitions as conduits rather than impediments in transferring environmental capabilities.*

Corporations are fluid entities, with as many as 7% of manufacturing facilities being sold from one corporation to another in a given year (Maksimovic & Phillips, 2001). Many academic studies have explored the consequences of such asset sales, but despite this effort, much still remains to be known about when and how these transfers in ownership create value for the acquiring firm, the acquired asset, or society as a whole (Eckbo, 2013). Thus far, most research has focused on the effect of ownership changes at the firm level, usually by analyzing the response of financial markets (D. R. King, Dalton, Daily, & Covin, 2004). A smaller literature has considered the effect of acquisitions on facility-level productivity (Lichtenberg, Siegel, Jorgenson, & Mansfield, 1987; Mingo, 2013). Such analyses are important for investigating the effect of asset sales on the delivery of private goods and services, but they do not fully capture their broader social consequences. In their summary of the literature, Haleblian et al. (2009: 488) note the need for more research on "the effect of acquisitions on stakeholders other than shareholders."

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One way that stakeholders such as communities and employees may be affected by acquisitions is through changes in environmental performance, such as the generation of toxic waste in the course of production. These effects are a subject of public interest and policy debate, but no quantitative study has investigated the effect of asset sales on environmental performance. This inattention is unfortunate for at least two reasons. First, information on the effect of assets sales would provide guidance to stakeholders and policy-makers who are concerned with environmental outcomes. Second, such empirical analysis could provide an opportunity to advance theories of both acquisitions and of the effect of corporate ownership on environmental performance.

Existing scholarship leads to differing predictions regarding the likely effect of asset sales on environmental performance. A long theoretical and empirical tradition supports the contention that asset markets discipline the actions of pro-social managers and thereby limit the ability of firms to provide social services such as environmental protection (Betton, Eckbo, & Thorburn, 2008). Consequently, asset sales could harm environmental stakeholders by removing "green" managers from positions of control and replacing them with managers more focused on stockholder returns. A rival prediction, however, arises from the growing literature on capabilities and environmental performance (Berchicci, Dowell, & King, 2012). Several scholars contend that differences in specialized capabilities determine varying levels of environmental performance (Hart, 1995; Hart & Dowell, 2011; Porter & Van der Linde, 1995). If so, assets sales could improve performance by facilitating the transfer of capabilities to locations where they are needed (Berchicci et al., 2012; Diestre & Rajagopolan, 2011).

A few case histories are often cited as demonstrating that the former, market discipline, perspective is most predictive (Gelles, 2015). In one example, the Pacific Lumber Company (PALCO) was raided by Charles Hurwitz and his financial supporter Michael Milken. To pay back the bonds that funded the acquisition, Hurwitz degraded PALCO's social and environmental performance, ending a scholarship program, tripling the cut-rate of trees, and ordering the clear-cutting of a protected old growth stand. The later sale of the iconic and progressive firm Ben and Jerry's to Unilever reinforced beliefs that asset markets impeded the social performance of public firms. Inspired in part by these cases, advocates proposed the creation of legal entities designed to protect managers from the discipline of asset markets. One of these, the Benefit Corporation, is intended to protect pro-social managers who might feel they must sell their operations even if doing so "compromised their own social and environmental values" (André, 2012: 133).

Such policy proposals discount the potential for asset sales to provide access to beneficial capabilities, yet a large literature in strategic management argues that capabilities of all types are not homogenously distributed across firms, and their location powerfully influences observed performance (Helfat et al., 2009). If specialized environmental capabilities are indeed important, then acquisitions might improve performance by easing their transfer to locations where they are needed. Unfortunately, quantitative research on the effect of asset sales on environmental performance has been limited to evaluating strategic decisions such as acquisition or expansion, and has not analyzed performance consequences (Diestre & Rajagopolan, 2011). Yet, there is reason to expect that acquisitions influence environmental outcomes. Berchicci et al. (2012) examine the flip-side of this issue and find that acquisition choice is influenced by environmental capabilities, as firms are more likely to acquire facilities that have similar environmental performance to their existing facilities, and that this tendency strengthens for more physically distant targets. In a post-hoc analysis, they also find initial evidence that environmental capabilities change at acquired facilities. However, they neither explain whether and how acquisitions have an effect on newly acquired targets' or existing facilities' environmental performance, nor explore possible mechanisms for performance changes. We analyze the same Toxics Release Inventory data that Berchicci et al. use and extend their paper both theoretically and empirically, in order to find evidence whether environmental capabilities potentially influence both acquisition choice and are in turn influenced by acquisitions. In our research, we develop and test hypotheses predicting situations in which asset-sales might facilitate performance improvement within either acquired units or incumbent operations. Our analysis advances understanding of how environmental capabilities are deployed, and the extent to which corporate ownership matters for environmental performance. Although the concept of environmental capabilities was first proposed over 20 years ago (Hart, 1995), well-identified empirical evidence of environmental capabilities remains scarce (Hart & Dowell, 2011). Research evaluating asset sales, because they provide a discernable and measurable shock, offers a new way to investigate the existence and importance of environmental capabilities.

Our analysis also informs the literature on the consequences of asset sales. Scholars in strategic management have proposed that capability flows may be conditional on the relative endowments of the selling and buying corporations. This theory has been evaluated through the use of retrospective surveys (e.g., Capron, Dussauge, & Mitchell, 1998), but a full test using actual performance changes has proven difficult to accomplish. Scholars have explored changes among either acquired or incumbent operations (Banaszak-Holl, Berta, Bowman, Baum, & Mitchell, 2002; Mingo, 2013; Natividad, 2014; Siegel & Simons, 2010), but we know of only one test of conditional changes among both acquired and incumbent operations (Maksimovic & Phillips, 2001). Our research extends their study by incorporating new data sources, new methods, and a new measure of consequence – one type of impact on environmental stakeholders.[1]

By evaluating facility-level changes, we gain additional insight on how acquisitions create value. Higher-level analyses, such as those at the firm level, combine effects from transaction costs, market power, and increased productivity. By examining the effects at the facility level, we can more precisely measure operational changes that are likely to be associated with access to new capabilities. This level of inquiry also enables post-hoc tests of possible mechanisms. For example, we can explore whether observed changes are the result of new corporate objectives. We can also evaluate possible mechanisms for capability transfer--such as personnel turnover. In doing so, we contribute additional insight on the human capital consequences of acquisitions.

Finally, as mentioned earlier, our study contributes to theories of the effect of asset markets on social stakeholders. Jensen (1988) proposed that while asset sales can be beneficial for shareholders, they could have negative effects on other stakeholders. To test the effect of corporate exposure to asset markets, scholars have compared the environmental performance of private and publicly held firms (Berrone, Cruz, Gomez-Mejia, & Larraza-Kintana, 2010; Doshi, Dowell, & Toffel, 2013). These studies' findings are suggestive, but our results provide more direct evidence of the effect of ownership change for stakeholders.

Environmental Capabailities and the Effect of Asset Sales

The notion that firms have scarce capabilities or resources that influence their performance is a central element of modern theories of strategic management. Karim and Mitchell (2000): 1063) define capabilities as "stocks of knowledge, skills, financial assets, physical assets, human capital, and other tangible and intangible factors (Amit & Schoemaker, 1993; Grant, 1996; Wernerfelt, 1984)." Shared corporate ownership allows diverse capabilities to be more easily transferred and thus put to more productive use. "At the heart of corporate strategy" write Foss and Lien (2010: 15) "is the notion that common ownership permits benefits from sharing, combining and pooling resources that would be difficult to obtain otherwise (Montgomery & Wernerfelt, 1988; Penrose, 1959; Prahalad & Hamel, 1990)." Consistently, scholars have uncovered empirical evidence to support the notion that corporate ownership facilitates the transfer of productive practices among commonly-owned units (Baum & Ingram, 1998; Darr, Argote, & Epple, 1995).

With respect to environmental performance, several scholars have suggested that differences in observed performance might reflect different bundles of capabilities held within corporations. Hart (1995: 991) argues that "waste minimization" is a "specialized capability" that simultaneously facilitates pollution reduction and cost savings. Porter & Van der Linde (1995) elaborate the point, arguing: "pollution often is a form of economic waste. When scrap, harmful substances, or energy forms are discharged into the environment as pollution, it is a sign that resources have been

[1] To date, most studies of facility-level consequences have used data from the US Census of Manufacturers (e.g., Siegel, Simons, & Lindstrom 2010). Authors using these data have urged the development of other data test-beds for use in extending findings derived from the Census data.

used incompletely, inefficiently, or ineffectively (1995: 121)."[2]

If a corporation's environmental capabilities partly drive the environmental performance that its facilities demonstrate, then, theory suggests, asset sales could provide an opportunity for transfer of these capabilities. Recent studies have suggested that environmental capabilities might influence corporate strategy. Diestre and Rajagopolan (2011) find that expansion into new product lines is more likely when the new line utilizes hazardous chemicals that the firm is already accustomed to processing, suggesting that such familiarity is a form of technological relatedness. In the most closely related paper to ours, Berchicci et al. (2012) use the same data we employ to investigate whether environmental performance is related to acquisition choice, and find that on average firms acquire facilities where their capabilities can be put to use. With a t-test of pre- and post-acquisition waste generation, they find initial evidence for post-acquisition change in capabilities. They do not, however, explain or explore whether and where performance changes occur, and they do not control for the endogeneity of the acquisition choice.

The nascent literature on the environmental effects of corporate acquisitions is coherent with a larger literature on capabilities and other types of operating performance. For example, based on retrospective survey evidence, Capron et al. (1998) argue that the relative strength of resources in the selling and acquiring firms will influence the location of performance improvement (Capron et al., 1998). If the firm buying the assets is stronger, performance within acquired assets (e.g., production facilities) should improve. If the selling firm is stronger, superior capabilities might diffuse from the new assets to incumbent facilities within the buying firm--improving their performance. Banaszak-Holl et al. (2002) make a similar argument in the nursing-home industry, arguing that corporations will follow either "turn around" strategies to improve acquired assets or "cream-skimming strategies" to enhance incumbent operations.

Scholars in finance and economics have created parallel hypotheses for a conditional effect of acquisitions on facility performance (Maksimovic & Phillips, 2001). These scholars do not use the language of capabilities, but do assert that corporations differ in their ability to support the facilities they own. Maksimovic and Phillips (2001) hypothesize that: (a) firms sell off poorly performing facilities to new owners that are better suited to run them, and (b) on average, such ownership changes result in performance improvements at the traded facilities. They further formalize this reasoning in a model whereby firms with superior abilities will acquire facilities until scale diseconomies equalize the marginal benefit and cost of doing so. To date, empirical research in the finance literature has resulted in a range of effects. Some studies report that performance at acquired facilities improves (Baldwin & Gorecki, 1998; Lichtenberg et al., 1987; Siegel & Simons, 2010), while others find that performance degrades before improving (McGuckin & Nguyen, 1995), or declines in a sustained way (Harris & Robinson, 2002). Maksimovic and Phillips suggest that one explanation for these varying results may be a lack of attention to the relative abilities of selling and buying firms. Acquired facilities, they argue, will only improve if purchased by corporations with superior performance.

In summary, prior studies have hypothesized that acquisitions can ease the transfer and application of capabilities, and that the direction of transfer will depend on the relative endowments of selling or acquiring firms. When an acquiring firm has superior capabilities, acquired units will tend to improve. Given evidence environmental performance depends, in part, on specialized capabilities, we hypothesized:

> *Hypotheses 1 (H1): When a facility is sold to a firm that has better environmental capabilities than its previous owner, the* acquired *facility's environmental capabilities will improve.*

The strategy literature also suggests that acquisitions may enhance capabilities within *incumbent* units in the acquiring firm. Nadolska and Barkema (2014) argue that firms that have sufficient absorptive capacity can develop new capabilities

[2] Both publications also note that waste is associated with increased disposal and regulatory costs, further expanding the economic value of waste reduction. Estimates of this secondary economic effect suggest that waste disposal reduces total-factor productivity by an average of 5% (Greenstone, List, & Syverson, 2012; Margolis & Walsh, 2003). Extensive research has attempted to reveal the value of these capabilities by measuring the relationship between discretionary environmental performance and financial returns. The evidence is mixed and incomplete, but on balance a small positive relationship has been observed (Margolis & Walsh, 2003).

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through their acquisition experiences. Vermeulen and Barkema (2001) propose that the act of bringing the new unit into the firm provides a "shock" that can create an opportunity for the incumbent facilities to break out of their rigidities and become more receptive to importing new capabilities.

Other strategy scholars argue that the acquiring firm may gain access to capabilities already within acquired units. Zollo and Singh (2004) argue that acquisitions can be an important means by which firms import codified capabilities that they do not already possess. Banaszak-Holl et al. (2002) argue that some firms follow a strategy whereby they attempt to enhance their incumbent operations by giving them access to the "cream" of available capabilities. Similarly, Capron et al. (1998) hypothesize that resources flow from stronger to weaker units following an acquisition. When the acquiring firm's units lack capabilities, they may gain them from newly acquired units.

Research on the effect of asset purchases on incumbent units at the acquiring firm is relatively scarce. The research that has been undertaken has found mixed evidence that acquisitions can lead to changes in incumbents, with Mingo (2013) finding that incumbent sugar cane operations experienced either improvement or degradation following acquisition. In contrast, Natividad (2014) finds little evidence of change in incumbents following acquisition in the Peruvian fishing industry. These studies, however, do not control for the relative performance of acquiring and selling firms and thus cannot assess the "cream skimming" pattern. In the only study that does control for the relative performance of buying and selling firms, Maksimovic and Phillips (2001) analyze the effect of asset sales on incumbent operations and find that the effect is contingent on the corporate-level productivity of the buyer and seller--*incumbent* operations improve if the acquiring firm buys an asset from a more productive firm. They describe this un-hypothesized result as initially puzzling, but note that it is "consistent with buyer[s] purchasing expertise or productive ability that can be transferred to existing assets" (Maksimovic & Phillips, 2001: 2057).

Thus, acquisitions can provide an opportunity for improvement among incumbent facilities at firms that acquire units with superior environmental performance. If environmental performance stems in part from capabilities, then when a firm with relatively lower performance acquires a facility from a seller that has higher performance, the buyer's incumbent units will have access to superior capabilities and their performance will tend to improve.

We therefore hypothesized:

Hypotheses 2 (H2): When a facility is sold to a firm that has worse environmental capabilities than its previous owner, the new owner's incumbent *facilities' environmental capabilities will improve.*

Data and Methods

Data

Testing our hypotheses requires a longitudinal dataset that includes facility-level environmental information and a measure of environmental performance. We use the U.S. Environmental Protection Agency's Toxic Release Inventory (TRI) because it covers facilities in manufacturing industries (two-digit *SIC* codes 20-39) employing 10 or more people and processing, using, or storing more than a threshold amount of over 600 toxic chemicals. Facilities report on all relevant chemicals, and the average facility reports on four chemicals per year. They also provide information on facility characteristics, firm ownership, production levels, managing personnel, and physical location.

Reduction in chemical waste provides a good measure of changes in the firm's environmental impact; for this reason TRI data have been widely used to measure environmental performance in management, economics, and sociology (e.g., A. A. King & Lenox, 2000; Klassen & Whybark, 1999; Konar & Cohen, 1997). Several scholars have proposed that reductions in chemical waste are related to specialized organizational capabilities (Christmann, 2000; Hart, 1995; A. A. King & Lenox, 2001). We follow other scholars by beginning our panel of TRI data in 1991 when the government-required survey first included detailed reporting on process waste. We terminate our panel in 2006 when the *SIC*/NAICS industry reclassification changed reporting requirements for some of the facilities in our sample.

One of the most significant advantages of the TRI database is that it includes information on both waste and production output (in units) at the line level. Facilities report to the TRI the amount of waste of each listed chemical that was produced as a byproduct of a particular production line. For

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example, if a facility produces both gloves and shoes, managers disclose separately changes in production output for each product as a ratio of the current year's production relative to the previous year (e.g., 1.1 signifies a 10% increase in the number of units produced on a particular line over the previous year). For each production line, managers report separately the waste generated in each operation (e.g., 1,000 lbs. of methylene chloride on the shoe line, 15,000 lbs. of ammonia on the glove line). Thus the "production ratio" provides a precise and disaggregated measure of changes in output.

Despite its advantages, the TRI database has several potential limitations. First, the TRI does not cover all facilities, only manufacturing facilities that employ 10 or more people and exceed the reporting threshold for one of the listed chemicals. This represents approximately 50% of the facilities identified by the U.S. Census and an even higher proportion of total production since the smallest facilities tend to be excluded. Second, while the TRI covers over 600 chemicals, other chemicals are in use. However, the TRI-listed chemicals have been deemed by regulators to be most significant and thus are assumed to most strongly influence environmental performance. Finally, the TRI provides data on only one aspect of environmental performance and does not capture other impacts such as energy consumption or land modification.

To acquire additional facility-level information, including corporate ownership, we linked facilities listed in the TRI to those listed in the National Establishment Time Series (NETS) database of Dun & Bradstreet (D&B) data. Contracted by the authors, NETS matched these D&B data to the EPA's TRI for the years 1991–2005 using names and addresses reported in the latter.

Empirical Strategy

In an ideal experimental world, we would randomly assign acquisitions across owners to facilities and compare behavior and performance before and after an acquisition event. Obviously, acquisitions are not randomly assigned, and our empirical strategy must account for this to the extent possible. Following best practice for archival research, we chose to test H1 by first creating a set of matched pairs and then by employing a "differences-in-differences" (DiD) analysis.

The goal of matching methods is to create a control group that is so similar to the treated group that the only systematic difference is the treatment itself (Iacus, King, & Porro, 2012). However, practical limitations may impede matching from achieving this ideal. First, the match depends on the quality of the available and observable measures. Second, the matching process cannot rule out the possibility that some unobserved difference influences both the treatment propensity and the outcome. Despite these limitations, absent natural experiments or the ability to create experimental designs, matching represents the preferred method to assess causality with archival longitudinal data (Iacus et al., 2012).

The DiD approach is suited to settings in which subjects can be observed before and after a treatment and the treated group can be compared to an untreated one (Bertrand & Mullainathan, 2003; Imbens & Wooldridge, 2009; Maksimovic & Phillips, 2001). Using this approach, we are able to analyze an acquired facility's performance before and after the acquisition, and compare its changes to those of a matched facility that did not receive this treatment.

In testing H1 and H2, we improve the accuracy and identification of our analysis by investigating changes for each chemical reported by a facility. Previous studies that have used TRI information have aggregated those data to the firm or facility level before conducting statistical analysis, but our approach of analyzing changes for each reported chemical provides a number of advantages. First, we can incorporate both chemical-year and facility-chemical fixed effects in the analysis, allowing us to control for both changes in chemical prices and disposal costs and for fixed differences in chemical technologies across facilities. Second, by avoiding the need to form an aggregated measure comprised of different chemicals to form a facility measure, we can avoid false inferences that might occur from changes in reporting requirements which add or drop chemicals. Finally, by directly analyzing changes of waste of a particular chemical, we can incorporate a precisely linked variable measuring changes in output for the production line where that waste was generated.

Calculation of Measures

Asset sale treatments. Scholars often use Securities Data Corporation (SDC) information to identify acquisitions, but these data are inappropriate for our purposes because they underrepresent sales of single facilities or partial business units;

SDC includes only acquisitions above 5% of the firm's value (Netter, Stegemoller, & Wintoki, 2011). We instead followed the precedent of those scholars who have explored assets sales by employing another panel of facility level data: the U.S. Census Bureau's Longitudinal Research Database (LRD) (Lichtenberg et al., 1987). Emulating these scholars, we use an ownership identifier within our database to identify asset sales. Our D&B data (provided by NETS) identifies the "ultimate parent" for each facility, an ID that is invariant to corporate name changes. Changes in these codes thus reflect either the creation of a new corporate entity or the transfer of an asset from one parent to another. By considering only those cases where the new corporate parent existed before the change, we can identify asset sales.

Our TRI data also include information on ownership changes, allowing us to double check the asset sales inferred from the D&B data. To be conservative, we require *both* sources to agree on a change of parent for a specific facility in a given year. Following this procedure, we identify 4,175 facilities acquired during our time period. Unfortunately, we cannot use all of these cases because we must be able to estimate both the performance of the old and new owner. This means that we cannot make use of an asset sale if, for example, a new parent previously had never reported to the EPA's TRI, because we cannot estimate their prior performance. In total, we are able to calculate the performance of the old and new owners for 3,130 asset sales.

To test Hypothesis 1, we first need to create a dummy variable delineating a facility that has been acquired. Second, we must separate these acquired facilities according to the different performance of their selling and buying owners (i.e., the acquiring form is more or less wasteful than the selling one). $Target\ Treated_{\textbf{Less Wasteful Acquirer}}$ is set equal to one for the 2 years following an acquisition of a target bought by a relatively *less wasteful* firm, and zero otherwise. $Target\ Treated_{\textbf{More Wasteful Acquirer}}$ is set equal to one for the 2 years following an acquisition of a target by a relatively *more wasteful* firm, and zero otherwise. We choose a 2-year window because we want to allow time for the treatment to take effect, but not so much time that other events will confound our results.

To test Hypothesis 2, we identify the incumbent facilities owned by the acquiring firms. We then separate these incumbent facilities according to the relative corporate environmental performance of the firms engaged in the asset sale. $Incumbent_{\textbf{Less Wasteful Acquirer}}$ is set equal to one for the 2 years for all incumbent facilities in an acquiring firm in which the firm is less wasteful than the selling firm, and zero otherwise. $Incumbent_{\textbf{More Wasteful Acquirer}}$ is set equal to one for the 2 years for all incumbent facilities in an acquiring firm that is more wasteful than the target's previous owner, and zero otherwise.

Asset sale matched controls. To reduce the bias that could arise due to endogenous selection of acquisition targets, we created two matched comparison groups that are similar to the treated groups ($Target\ Control_{\textbf{Less Wasteful Acquirer}}$, $Target\ Control_{\textbf{More Wasteful Acquirer}}$). The many methods of matching treatment and control groups (e.g., propensity score, exact matching, and coarsened exact matching) all involve matching based on a comparison of attributes that are most likely to explain why one subject experiences the event while another does not. Following current best practice, we use the *Coarsened Exact Matching* (CEM) method (Blackwell, Iacus, King, & Porro, 2010; Iacus et al., 2012). To explain the concept of coarsening, Blackwell et al. (2010) use the analogy of a histogram: a continuous variable is coarsened into a few bins and observations are matched according to bin. This coarsening produces exact matches within the confines of each coarsened bin.

We follow the CEM procedure to match a facility that experienced an ownership change with a facility with similar characteristics that did not experience an ownership change. Good matching depends on the chosen covariate set. To ensure their quality, we follow the only paper that has modelled the acquisition choice using TRI data (Berchicci et al., 2012) and use most of their determinants for acquisition choice. We match facilities on *exact* values of industry affiliation (using a two-digit *SIC* code) and year prior the acquisition. In this way only facilities belonging to the same industry and in a given year are matched. In addition, we also match on three continuous variables: (a) *facility size*, calculated as the estimated value of facility sales (from NETS/D&B) in a given year; (b) *the facility waste generation* (using the same waste measure employed to create the clean and dirty firm classification for 2 years prior to an acquisition); and (c) *the trend of facility waste generation growth* (using 2 years prior to an acquisition). Matching on size and on trends in waste generation increases the

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similarity between the treated and control facilities and minimizes the unobservable differences in the pre-treatment phase. Including the trends in waste also helps reduce concerns of endogeneity--if the treated and control facilities display similar waste trends prior to treatment, but diverge afterwards, it is likely that the treatment is truly associated with the change.

Before matching, the three variables are transformed into logarithmic forms, then normalized by year and industry (based on two-digit *SIC* codes), making each value for a given facility the distance to the mean value for a given industry sector in a given year. Thus, these variables allow us to create a control group within the same industry that is similar in size to the treated group within a similar range of waste trends and growth. Based on these matches, we form two control groups for the two treated groups: facilities acquired by less wasteful firms, and facilities acquired by more wasteful firms.[3] Lastly, we perform t-tests to ensure that there are no significant differences between the matched and treatment groups and perform additional diagnostics to test the reliability of the matching (see Table S1). Matching reduces the number of facility acquisitions we can analyze from 3,130 to 2,292 (1,189 plants bought by less wasteful acquirers and 1,103 plants bought by more wasteful acquirers). For 75% of these facility cases, only a single facility changed hands, in 20% two facilities were sold, and for the remaining 5%, three or more facilities were transferred between corporate parents.

To ensure the robustness of our findings to various matches, we ran other matching analyses using a larger set of covariates to make the matching more stringent. Doing so caused a significant decline in the number of matched asset sales. For example, in one of our attempts we included the U.S. state identifier as a required exact match to take into account for the location effect as one of the important determinants for asset choice (Berchicci et al., 2012). It resulted in a 70% reduction in matches, yet even this small matched set, we get similar results (though with somewhat inflated standard errors due to the smaller sample). Thus, we report findings from the more complete analysis.

In testing H2, we needed to match an incumbent that receives a treatment with one that does not. This complicates the matching, because an ideal match would begin with the firm level, since firms making acquisitions are presumably different from those that do not. Once that match is accomplished, we could compare an incumbent facility in the acquiring firm the acquisition with a matched facility at the matched control firm. Unfortunately, such a "double matching" process results in only 8% of our asset sales being matched. As a second-best solution, we attempted to match only at the facility level and match an incumbent facility at a treated firm against an incumbent at a firm that did not make an acquisition that year. With this approach, we lose only 15% of our prior matches. The results using this matching (available on request) are very similar to those obtained without any matching. Since these results reduce our asset sales by 15%, without changing the results, and are an imperfect way to match, we proceed with testing H2 without utilizing a matching analysis.

Former and new owner capabilities. To compare the corporations' relative levels of capabilities, we followed a method used in previous research to compare corporate performance (Diestre & Rajagopolan, 2011; Gamper-Rabindran & Finger, 2011; A. A. King & Lenox, 2002). We followed previous research by using a regression analysis to create a performance score for all facilities in a given sector and year. For each industry (four-digit *SIC*) and year, we regressed a polynomial of facility size on total waste generated. We then estimated performance as the deviation of the firm's actual performance relative to the prediction of the regressed model for a facility of identical size, year, and industry. Firms with a positive score produced more waste than comparable facilities in the same year and sector. We normalized these scores using the standard deviation of the error, so that when creating a corporate level score, we did not unduly emphasize any particular facility.

This method has several advantages. First, it mirrors the total-factor productivity measure that has been commonly used in facility-level acquisition studies (Siegel & Simons, 2010). Second, it can be applied to a large and diverse set of firms: small and large, across industry sectors, and with both public and private ownership. Finally, firm-performance measures can be created by summing the scores (residuals) for all facilities owned by the firm. In the analysis presented, we use a summation method

[3] We coarsen these covariates by three cut points, thereby dividing the distributions into four bins per year and industry sector. The number of bins or interval sizes can be created automatically by the program or specified manually. We tested both methods before choosing a manual specification of four bins.

weighted by facility size, but we also conducted robustness tests using a corporate performance measure based on an equal-weighted aggregation.

Environmental capabilities: change in waste generation. We operationalized our dependent variable, changes in environmental capabilities, as the change in waste generated for a given chemical. To construct this measure, we first created a variable, *Waste Generation*$_{cit}$, measured as the pounds of waste for chemical *c* in facility *i* in year *t*. It included all the waste generated by a particular chemical regardless how it is disposed of (for example through releases, recycling, treatment, or energy reconversion). In this way, we were able to measure the whole volume of waste produced rather than examining one particular source or mode of disposal. We then created a panel of waste volumes for a chemical *c* within a facility *i*, and we calculated the *change in waste generation* (our dependent variable) as the log changes in waste for a given chemical *c* for a given facility *i* from the current year *t* to the subsequent year *t + 1*.

$$\begin{aligned} &\textit{Change in Waste Generation}_{cit+1,t} \\ &= \ln\left(\frac{\textit{Waste Generation}_{cit+1}}{\textit{Waste Generation}_{cit}}\right) \times 100 \quad (1) \end{aligned}$$

We multiplied the logarithmic transformation by 100 so that for small changes the coefficient can be interpreted as the percentage changes in the dependent variable. For example, a 10% increase in waste would be calculated: $\ln\left(\frac{110}{100}\right) \times 100 = 9.5$. Positive values for *Change in Waste Generation* corresponded to an increase in waste generation in *year*$_{t+1}$ relative to the previous year for a given chemical *c*. Thus, the facility would experience a *worsening* of its environmental capabilities. We recognize that lower waste generation can stem from sources other than capabilities, for instance from installation of equipment or establishing new goals, and in general that acquisitions affect more than capabilities. Thus, in our post-doc analysis section we ran a set of tests that provide further evidence that the changes we observe are more likely to be due to capability transfer than other plausible mechanisms.

Change in production volume. Because changes in waste generation could be caused by variations in production output, we controled for fluctuations in production. As discussed earlier, the TRI data included a production ratio measuring the change in the number of units of a good produced in the current year relative to the prior year. These data are reported for each line of business within the facility that generated a particular type of chemical waste, and thus we have accurate data for production changes associated with each waste chemical reported to the TRI. Using these data, we created a measure of the *Change in Production Volume*:

$$\begin{aligned} &\textit{Change in Production Volume}_{cit+1,t} \\ &= \ln\left(\frac{\textit{Production Volume}_{cit+1}}{\textit{Production Volume}_{cit}}\right) \times 100 \quad (2) \end{aligned}$$

where (*Production Volume*$_{cit+1}$/*Production Volume*$_{cit}$) is the production ratio of the line of business that is associated with waste chemical *c* at facility *i* in year *t*. For example, it could be the number of shoes produced in the process that included use (and some wastage) of a particular chemical. As for the dependent variable, we multiply the logarithmic transformation by 100. Positive values for *Change in Production Volume* correspond to an increase in production activities in *year*$_{t+1}$ relative to the previous year.

Model Specifications

We test our hypotheses using a regression analysis employing numerous fixed effects.

$$Y_{cit+1,t} = \beta\boldsymbol{\theta}_{it} + \beta CP_{cit} + \beta D_{ct} + u_{ci} + e_{cit} \quad (3)$$

where $Y_{cit+1,t}$ denotes the log change in waste generation for chemical *c* for facility *i* between year *t* and *t + 1* as described in Equation (1) above. The vector $\boldsymbol{\theta}_{it}$ includes all of the dummy variables used to measure the effect of an asset sale (*Target Treated, Target control, etc.)* for each facility *i* in year *t*. For H1, $\boldsymbol{\theta}_{it}$ is a set of four variables identifying target facilities acquired by more or less wasteful parents (as well as variables marking the associated matched control facilities). To test H2, $\boldsymbol{\theta}_{it}$ identifies incumbent facilities in more or less wasteful firms that recently acquired a new facility. CP_{cit} is the change in production volume for chemical *c* at facility *i* in year *t*. Rounding out the model are chemical-year dummies D_{ct},

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facility-chemical fixed effects u_{ci} and an error term e_{cit}. We used "chemical-facility" fixed effects to control for time-invariant approaches for a given chemical at a given facility. We employed chemical-year fixed effects to absorb the effect of unobserved shocks effecting chemical prices or disposal costs. In combination, the chemical-year dummies also account for macroeconomic trends.

Because we have multiple observations for facilities in a given year, our observations are not independent within facilities. Consequently, our standard errors could be correlated and our degrees of freedom inflated. To correct this problem, we clustered the standard errors at the facility level. Using clustered errors relaxed the assumption that our error terms (e_{cit} or ε_{cit}) were independently and identically distributed. We used the Huber-White sandwich estimator (Huber, 1967; White, 1980; Wooldridge, 2002) for the reported results, but because the sandwich estimator can estimate correlation in error only along the diagonal of the variance–covariance matrix, we also performed robustness tests using bootstrap estimation of our error structure (Mooney & Duvall, 1993). This procedure enabled us to estimate the unobserved error structure, correct for undesirable associations among the errors, and confirm the significance of our coefficient estimates.

Descriptive Statistics

Table 1 presents the descriptive statistics for our sample. Because of the number of fixed-effects used in our model, we were able to employ few control variables. In terms of the dependent variable, *Change in Waste Generation*, the data reveal that waste is declining about 1.7% per year over the sample. It suggests that across our panel the environmental performance is slightly improving. This is consistent with the increased regulation firms faced, and stakeholder pressure brought on by the transparency provided by the Toxic Release Inventory itself. The data show that, within a given line of business for a facility, production volume also decreased over time (the mean "Change in *Production Volume*" is −0.059 or about −0.06% per year). These small changes hide wide variability. The standard deviation in the change of production volume is 45.7 and for the change in waste generation the standard deviation is 115.1. Because our data are at the production line level (i.e., for a single product), this suggests large changes in production of particular products.

Results

Table 2 presents our core analysis. In Model 1, we provide a baseline test of the overall effect of asset sales on all acquired facilities. The coefficient of *Target Treated* for the 2 years following an acquisition has a positive value (B = 0.183 or about 0.2% more waste volume per year), and it is less than the coefficient estimated for matched control facilities (B = 0.884). The 95% confidence interval for both estimates includes zero. To test if the coefficients are meaningfully different from each other, we reran the analysis using fixed-effects for each matched pair. This allows us to directly evaluate post acquisition differences between the treated and control facilities: the 95% confidence interval for the difference between the coefficients includes zero. Thus, based on our comparison of acquired and matched control facilities, we cannot conclude, based on frequentist inference thresholds, that there is a tendency for acquisitions to either harm or improve environmental performance.

Model 2 provides the simplest test of Hypothesis 1. We separate the treatment effect of targets into two cases: they are acquired by (a) an owner with better performance (less waste) or (b) an owner with worse performance (more waste) than their current owner. We find that facilities bought by less wasteful acquirers experience an *additional* decrease in waste of 4.6% per year (B = −4.599, T = −2.55) beyond the overall trend for U.S. manufacturers. In contrast, waste at the matched control facilities for this group actually grows slightly, though the estimate is sufficiently uncertain that no inference can be made with confidence. We also ran a Wald test to compare the coefficients of the treated and control groups and the test confirms that they significantly differ (Prob > F = 0.018). In summary, we find evidence consistent with H1: facilities bought by less wasteful acquirers experience an improvement in their environmental performance.

Although we did not develop a hypothesis about targets bought by a lower performing (more wasteful) firm, for consistency we also estimate the effect of such acquisitions on facility waste generation. We find that these facilities experience an additional increase in waste of about 6% per year (B = 6.039, T = 2.82) for the 2 years following an acquisition.

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Table 1
Descriptive Statistics and Correlations (607,069 Observations)

Variable	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9
(1) Change in Waste Generation	−1.73	115.126	−1715.1	1611.8									
(2) Target: Treated	0.032	0.177	0	1	0.00								
(3) Target: Control	0.018	0.132	0	1	0.00	0.04							
(4) Target $\text{Treated}_{\text{Less Wasteful Acquirer}}$	0.019	0.135	0	1	0.00	0.76	0.02						
(5) Target $\text{Control}_{\text{Less Wasteful Acquirer}}$	0.011	0.104	0	1	0.00	0.03	0.78	0.03					
(6) Target $\text{Treated}_{\text{More Wasteful Acquirer}}$	0.014	0.118	0	1	0.00	0.65	0.04	0.01	0.00				
(7) Target $\text{Control}_{\text{More Wasteful Acquirer}}$	0.008	0.091	0	1	0.00	0.04	0.69	−0.01	0.16	0.07			
(8) Incumbent $\text{Treated}_{\text{More Wasteful Acquirer}}$	0.096	0.294	0	1	0.00	0.00	0.02	−0.02	0.00	0.02	0.03		
(9) Incumbent $\text{Treated}_{\text{Less Wasteful Acquirer}}$	0.120	0.325	0	1	−0.01	0.01	0.04	0.00	0.03	0.01	0.03	0.24	
(10) Change in Production volume	−0.059	45.711	−460.5	1377.2	0.16	−0.01	0.00	−0.01	0.00	0.00	0.00	−0.01	−0.01

Waste at the matched facilities for this group falls, but to a lesser extent, and the 95% confidence interval for the difference between the treated and control groups includes zero. As before, we calculate the distribution of the estimate of the difference between the treated and control groups by estimating a model grouped at the pair level. We confirm that the treated facilities bought by more wasteful corporations suffer reductions in environmental performance (Wald test: Prob > F = 0.030). This is an unexpected result, and we attempt to interpret it later in this article in light of additional post-hoc analyses.[4]

Model 3 conducts a parallel analysis for the effect of acquisition on incumbent facilities within acquiring firms. Consistent with H2, we find that when a more wasteful company buys a facility from a less wasteful firm, incumbent facilities reduce waste by about an additional 1.8% per year ($B = -1.848$, $T = -1.66$) beyond the overall trend for U.S. manufacturers, but we must be cautious in interpreting this result since the 95% confidence interval includes zero at one extreme. Model 4 includes all of the categories of facilities estimated in Models 2 and 3 and provides consistent results.

Our results so far support H1, and are consistent with H2, but the large standard error on the latter estimate suggests both caution and the potential for a hidden contingency. One possibility is that only some incumbent operations benefit from capability transfers after acquisition, because capabilities flow more readily in some circumstances than others. Previous research has suggested that similarity between sender and receiver facilitates capability transfer (Finkelstein & Haleblian, 2002; Mingo, 2013). This effect is more pronounced when the nature of the knowledge is complex and context specific (Larsson & Finkelstein, 1999; St. John & Harrison, 1999) as in the case of waste-reduction capabilities, where one important contextual factor may be industry similarity (Berchicci et al., 2012; Diestre & Rajagopolan, 2011; Doshi et al., 2013).

To explore this contingency, we separate incumbent facilities into those that share an industry with a newly acquired facility and those that do

[4] One might think that mean regression might provide an explanation for these findings, but there are two reasons to doubt this. First, the performance of the previous owner is evaluated *excluding* the target facility, so the relative performance of the selling owner need not imply information about the target itself. Second, the target is matched to a control facility, and mean regression should thus operate within this matched facility as well.

Table 2
Changes in Waste Generation in the Year of the Acquisition and the Year After Acquisition

			Change in waste generation (all facilities)					
	Hypothesis		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Effect on target	Target Treated		0.183					
			(.897)					
	Target Control		0.884					
			(.678)					
	Target Treated$_{\text{Less Wasteful Acquirer}}$	H1(−)		−4.599		−4.915		−4.454
				(.011)		(.007)		(.014)
	Target Control$_{\text{Less Wasteful Acquirer}}$			3.304		3.289		3.284
				(.233)		(.234)		(.234)
	Target Treated$_{\text{More Wasteful Acquirer}}$			6.039		5.897		5.800
				(.005)		(.006)		(.007)
	Target Control$_{\text{More Wasteful Acquirer}}$			−2.043		−1.906		−1.711
				(.469)		(.500)		(.544)
Effect on Incumbent	Incumbent$_{\text{More Wasteful Acquirer}}$	H2(−)			−1.848	−1.869	1.667	1.485
					(.096)	(.092)	(.196)	(.250)
	Incumbent$_{\text{Less Wasteful Acquirer}}$				−1.083	−1.170	−1.668	−1.624
					(.164)	(.134)	(.131)	(.141)
	Incumbent Same Industry$_{\text{More Wasteful Acquirer}}$						−6.284	−5.995
							(.000)	(.000)
	Incumbent Same Industry$_{\text{Less Wasteful Acquirer}}$						0.936	0.727
							(.479)	(.582)
	Change in Production Volume		0.524	0.524	0.524	0.524	0.524	0.524
			(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
	Year dummies		Yes	Yes	Yes	Yes	Yes	Yes
	Constant		−3.775	−3.701	−3.129	−3.068	−3.088	−3.057
			(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
	Observations		607,069	607,069	607,069	607,069	607,069	607,069
	Adjusted R-squared		0.03	0.03	0.03	0.03	0.03	0.03

P-values in parentheses. Chemical-year fixed effects and chemical-facility fixed effects. Standard errors clustered at facility level.

not. To do so, we first calculate whether incumbents operate in the same industry as the target acquired (based on two-digit *SIC* codes). Next, we create the following variables: *Incumbent Same Industry*$_{\textit{More Wasteful Acquirer}}$ and *Incumbent Same Industry*$_{\textit{Less Wasteful Acquirer}}$, that capture whether incumbents of an acquirer firm share the industry affiliation with the newly target-acquired given the relative corporate environmental performance. Support for this contingency would be indicated if we find a larger (negative) coefficient for those incumbents that share an industry with the acquired facility than for those in different industries. Model 5 tests this contingency and shows that when a more wasteful firm acquires a facility from a less wasteful (better environmentally performing) firm,

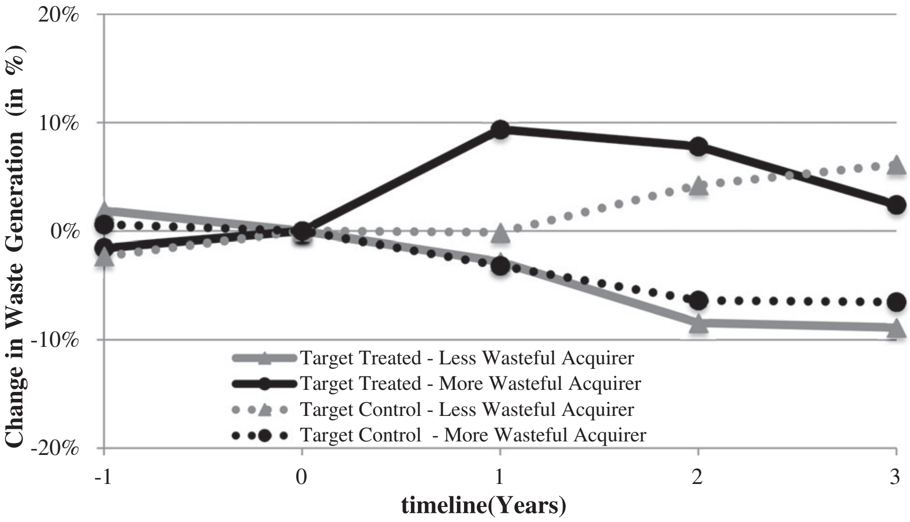

Figure 1. Changes in waste generation: treated and control groups.

incumbent operations in the same industry as the new acquisition improve their environmental performance dramatically (about an additional 6.3% per year: B = −6.28, T = 3.85). Neither the 95 or 99% confidence interval include 0, so we infer evidence that when a corporation buys a facility from a seller with superior environmental performance, incumbent operations within the acquiring firm tend to improve if the share the industry of the acquired unit.

Model 6 shows the full model, revealing that coefficient estimates are consistent with the more specific models.[5] In summary, we infer that we find support for H1, have evidence consistent with H2, and strong support for a conditional influence of H2: incumbent operations in the same industry as the targets newly acquired from a more capable (least wasteful) corporate owner are likely to improve their environmental performance.

To create a graphical depiction of the effects we estimate, we conducted an additional analysis using dummy variables for each of several years before and after acquisition (Figures 1 and 2). We then computed net changes relative to the acquisition year (marked as year 0). The graph plots net changes relative to this base year for both the following and preceding years. Changes for an individual year can be approximated by inspecting the changes in the Y-axis between two consecutive years.

Figure 1 compares acquired facilities (targets), represented by solid lines, to the matched controls, dashed lines. It shows that most improvement in facilities acquired by less wasteful firms occurs in the first 2 years after acquisition (~3% in the first year and ~6% in the second year), and that these improvements slow in the third year but do not reverse, resulting in a durable 9% improvement. Note that the control facilities for these groups experience a slight increase in waste. The graph also shows the unexpected worsening (increase in waste) among facilities acquired by relatively more wasteful firms, though there is a reversal of this trend after the first year. Again, the matched controls for those facilities show a different trend.

Figure 2 shows the effect of acquisition on the incumbent facilities. We see that incumbent facilities do not exhibit much change in waste generation after their parent firm acquires a new facility from a less waste-efficient firm. This is consistent with the idea that few capabilities are being transferred from these new acquisitions to *all* incumbent facilities in the corporation. And, consistent with our previous estimates, we see that incumbent facilities owned by more wasteful firms that operate in the *same industry* as the newly acquired targets show a substantial improvement in their environmental performance: the cumulative effect of the change in waste generation is about net 11% for the 2 years.

[5] We ran Wald tests for all the models to compare the coefficients of the treatment and control groups. We report the relevant tests in the text and note that all tests show that the coefficients are significantly different from each other.

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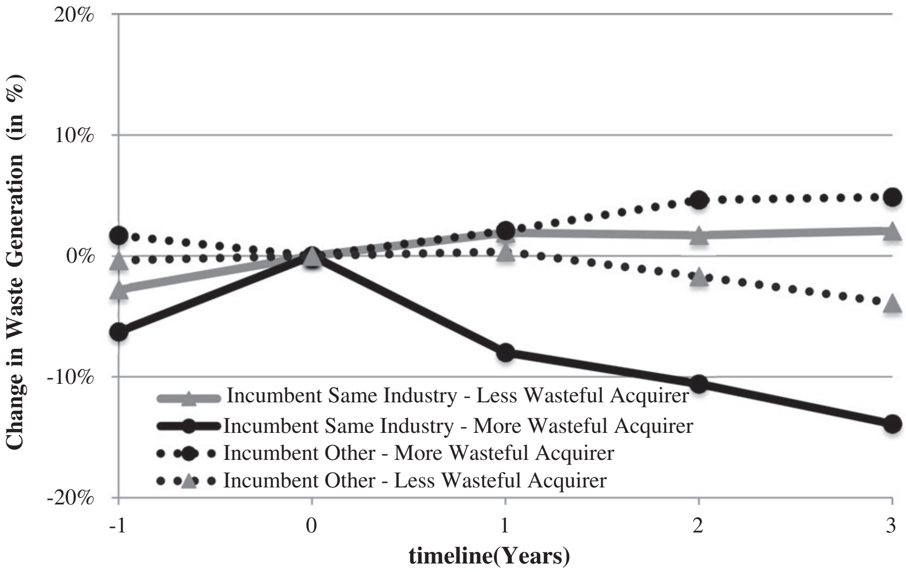

Figure 2. Changes in waste generation: incumbent facilities.

Post-hoc Analysis of Potential Mechanisms

The evidence we have presented so far is consistent with the transfer of capabilities, but we conducted three additional post-hoc analyses in order to corroborate our contention that capability transfer is the mechanism driving post-acquisition changes.

First, based on previous research, we conjectured that capability transfer could occur through changes in relevant personnel (in our case, those workers and managers most involved with the chemicals we measure) at acquired or incumbent facilities. Previous research has found significant evidence that acquisitions can result in changes in targets' top management teams (Walsh, 1988; Zollo & Singh, 2004), but turnover at the production level has been little explored (Siegel & Simons, 2010). To explore evidence of this mechanism, we analyzed personnel turnover among key environmental personnel in facilities that experienced a recent acquisition.

The data for our analysis come from the Toxic Release Inventory forms, which include the identity of both the technical person who provided the information and a supervisor who confirmed the forms veracity. These data are provided for each TRI form (essentially each toxic chemical) so they provide a reasonable proxy for the identities of key waste management personnel. From these data, we can create a range of employee turnover measures. In Table 3, we report results for one possible measure, *waste management turnover*, which is set to one for the first year in which both a new technician and a new certifier appear in the record. It takes a value of zero when either of the names was reported on a previous form for that facility.

Table 3 reports the results from a logistic regression analysis of the association between an acquisition and changes in waste management personnel. Model 1 shows that Targets Treated tend to experience personnel change, the effect is, however, contingent to the type of acquisition. When we separate the targets in two groups (targets treated bought by less wasteful acquirers and targets treated bought by more wasteful acquirers), the results indicate that, consistent with our performance evidence, only targets bought by less wasteful acquirers are more likely to change their waste-management team as shown in Model 2 ($B = 0.298$, $T = 9.61$, Wald test: Prob > chi2 = 0.000). Likewise, Model 3 shows that *incumbents* from more wasteful acquirers are more likely to experience a personnel change. This aggregated effect again masks the same industry contingency we uncovered in our analysis of performance change: when we separate incumbents that share an industry with an acquired target, we find that Incumbents Same Industry (More Wasteful Acquirer) are the only ones who are more likely to change their waste-management team, as shown in Model 4 ($B = 0.18$, $T = 6.52$).

The findings of our first post-hoc test are consistent with capability transfer. Overall, facilities acquired by firms with better environmental

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Table 3
Changes in Personnel in the Year of the Acquisition and the Year After Acquisition

	Waste management turnover (technician and certifier)			
	Model 1	Model 2	Model 3	Model 4
Target Treated	0.198			
	(.000)			
Target Control	−0.158			
	(.000)			
Target Treated$_{\text{Less Wasteful Acquirer}}$		0.298		
		(.000)		
Target Control$_{\text{Less Wasteful Acquirer}}$		−0.249		
		(.000)		
Target Treated$_{\text{More Wasteful Acquirer}}$		0.010		
		(.781)		
Target Control$_{\text{More Wasteful Acquirer}}$		0.025		
		(.632)		
Incumbent$_{\text{More Wasteful Acquirer}}$			0.098	−0.012
			(.000)	(.589)
Incumbent$_{\text{Less Wasteful Acquirer}}$			−0.122	−0.023
			(.000)	(.259)
Incumbent Same Industry$_{\text{More Wasteful Acquirer}}$				0.183
				(.000)
Incumbent Same Industry$_{\text{Less Wasteful Acquirer}}$				−0.175
				(.000)
Change in Production Volume	0.001	0.001	0.001	0.001
	(.000)	(.000)	(.000)	(.000)
Waste Generation	−0.008	−0.008	−0.008	−0.009
	(.018)	(.016)	(.016)	(0.012)
Year dummies	Yes	Yes	Yes	Yes
Observations	402,426	402,426	402,426	402,426
Pseudo R-squared	0.044	0.044	0.044	0.044

P-values in parentheses. Chemical-year fixed effects and chemical-facility fixed effects.

performance (less wasteful acquirer) tend to improve after the acquisition and they are more likely to experience a change in their waste management team. Likewise, incumbent facilities that share an industry with a newly acquired facility from a relatively less wasteful firm tend both to reduce waste *and* experience turnover. Yet this corroborating evidence should be viewed with caution, because we cannot show that the personnel turnover causes the observed performance change. We lack, unfortunately, an exogenous instrument and sufficient observations to allow estimation of the causal pathway.

In our second post-hoc analysis, we take advantage of the unexpected result that average performance declined in facilities acquired by more wasteful firms. There are two main rival explanations for this decline. First, this pattern could reflect exactly the fears that André (2012) described with regard to asset sales that the prior attention to environmental issues at these facilities has been downgraded by new owners. Second, it could reflect a process in which capabilities are appropriated, at least temporarily, from the targets, in order to improve the rest of the firm's units. This could occur, for example, if key personnel are moved to new locations in order to facilitate capability transfer. In the former case, we would not expect to see the incumbent facilities at these *same* firms improve, while in the latter case, we would. Accordingly, we infer that if we see degradations in performance at acquired units occurring simultaneously with improvement among incumbent facilities in the same corporation, then capability-stripping and transfer is more likely. If, however, there is no such pattern (i.e., the decrease in performance happens at units where there is no concomitant improvement in the incumbents), the degradation is more likely to be due to the more wasteful firms deemphasizing their new units' environmental performance.

To help us separate the effect of attention and capability transfer, we matched each target bought by more wasteful acquirers with one or more similar-size incumbents owned by the firm that operated within the same industry. Although, this approach results in a steep reduction in the number of acquisitions we can analyze (we lose 50% of our matches), we nevertheless find a negative and significant relationship between the degree to which targets experienced increases in waste *at the same time* that incumbents' operations in the same industry experienced waste decreases. Moreover, we only find this pattern when the acquirer was previously inferior to the former owner, and thus can be presumed to benefit from capabilities held within the acquired facility. The pattern we observe is consistent with the ideas that capabilities are appropriated from targets in order to improve the incumbent facilities. However, we need to be cautious with this interpretation, because of the reduced sample involved.

In our final analysis of alternative mechanisms, we investigated whether managers forecast the changes in waste we observed. If the observed changes were forecast by managers, it would suggest that new owners were changing performance goals or incorporating other relatively concrete actions. Alternatively, if the changes were not forecasted by managers, it is evidence in favor of more tacit acts such as capability transfer. The TRI requires managers to predict the volume of each type of chemical waste that will be created in the subsequent year. We conjectured that if a new corporate owner sets stricter performance goals (e.g., the facility must reduce waste by 10%), this would show up in these predictions. Although not shown here, we reran the models in Table 2 with the addition of one variable--*the predicted waste level.* It captures the waste level estimated by the reporting team for the next year. Based on our analysis, we could assess whether waste-level goals indeed are aligned with actual waste levels. We find that the inclusion of these expectations did not change our reported findings. Thus, we infer our evidence pointed to a mechanism more consistent with a process of learning (i.e., unanticipated capability transfers occurring between units) than of goal setting.

Robustness Tests

We used precedent, current practice, and our best judgment in determining our baseline estimation methods. However, to ensure that our results are robust, we also performed a number of additional tests.

Facility level analysis. Because we analyzed the waste reduction using a novel level of analysis (individual chemical), we also tested whether our results were robust at the level used by most prior TRI-based research and aggregated the observations at facility level using unweighted average of chemical waste and production outputs. Table S2 shows the findings, which are consistent with our analysis at the chemical level.

Alternative measures of the relative difference between the acquiring and selling firms. To test the robustness of our results to these different specifications, we conducted alternative tests using different measures of the relative wastefulness of the selling and acquiring firm. We measured wastefulness differences comparing, (a) the acquiring firm's average performance and that of the target facility, (b) facilities owned by the seller and the acquirer in the same industry (two-digit *SIC* code), and (c) the target facility and the most proximate facility owned by the incumbent. In all cases, we obtained results consistent with those presented here, suggesting that our results are not driven by a particular operationalization of the measure of relative firm wastefulness.

Full sample analysis. While we believe that the CEM approach is the most suitable method for testing our hypotheses, as it accounts, in part, for the endogeneity of acquisition choices, we recognize that it has limitations. Most importantly, in creating matches, we lose those acquisitions that cannot be matched. This can itself create some bias in the estimates due to sample selection issues. Thus, we replicated our analysis using the full sample of acquisitions. The results (available upon request) are consistent with those presented in Table 3.

Discussion and Conclusion

In this article, we analyze the implications of asset sales for one measure of environmental performance, the generation of toxic waste byproducts. In doing so, we respond to previous calls for more research on the effect of acquisitions on stakeholders (Haleblian et al., 2009). Although prior research suggests that ownership change might have significant effect for environmental stakeholders (Berrone et al., 2010; Doshi et al., 2013), the only direct evidence for the relationship between environmental capabilities and acquisitions is provided by Berchicci et al. (2012). That paper demonstrates that indeed environmental capabilities matter and can influence which facilities firms choose to acquire. They find that firms with superior environmental capabilities are significantly more likely to acquire physically proximate facilities with inferior environmental capabilities and vice versa. Here, we build on Berchicci et al.'s work and extend it by exploring and explaining whether acquisitions matters for environmental performance. First, we developed hypotheses that tie changes in environmental capabilities to performance differences between acquiring and selling firms. Second, we considered effects at both acquired facilities and at "incumbent" facilities at acquiring firms, offering a more complete view of how acquisitions may facilitate transfer of environmental capabilities. Finally, we employed a series of post-hoc tests that both help to identify that capability transfer underlies the observed changes, and outline mechanisms by which the transfer may be accomplished. When taken together, our research and the work of Berchicci et al. suggest that acquisitions are influenced by target's environmental performance and in turn they matter for environmental performance changes for both targets and incumbent facilities. In other words, they imply that environmental performance and corporate strategy are deeply intertwined, where environmental capabilities provide the input for a strategic decision while also being influenced by that decision.

Our results have implications for multiple literatures. For research in strategic management, and particular that stream concerned with strategic implications of acquisitions, we provide new and comprehensive evidence to refine theories for the effect of ownership changes on the flow of capabilities among acquired and continuing operations. For the broader literature on the effect of ownership changes in finance and economics, we provide new and confirmatory evidence that may explain seemingly contradictory results from previous studies. For the burgeoning literature on business and the natural environment, we provide indications of the existence of environmental capabilities. Finally, for policy makers, we provide new insight on the value of regulation to protect stakeholders by limiting asset sales.

Our findings support theories that asset sales allow valuable capabilities to flow to either newly acquired units or to incumbent operations (Banaszak-Holl et al., 2002; Capron et al., 1998), and that the direction of flow depends on the relative endowments of the selling and acquiring owners. We show that environmental performance improves among acquired assets if the new owner has exhibited superior performance in the past. Conversely, we show that incumbent operations improve if the acquiring owner had exhibited inferior performance. To further evaluate whether these patterns reflect capability transfer, we conducted a series of post-hoc tests. We observed patterns of employee turnover that are consistent with an explanation that skills are being transferred. We also find evidence that the changes exceed what managers at the facilities anticipate, which is again suggestive that more tacit changes, such as those associated with capabilities, are part of the reason for the performance changes.

Our research provides one of a few complete tests of the full capability theory of acquisitions (Banaszak-Holl et al., 2002; Capron et al., 1998; Zollo & Singh, 2004). Scholars have hypothesized that direction and degree of resource redeployment depends upon the relative resource positions of the buying and acquiring firm, but fully testing this contingent effect has been difficult. Several scholars have explored changes among either acquired or incumbent operations (Mingo, 2013; Natividad, 2014; Siegel & Simons, 2010). The only full test of conditional changes among both acquired and incumbent operations occurs as a result of analysis of a theory in the finance literature (Maksimovic & Phillips, 2001). Thus our research provides needed longitudinal evidence of actual changes in operational performance at both acquired and continuing units. In doing so, it provides solid empirical support for theories of contingent post-acquisition capability transfer.

Our results also speak to the broader strategic management research on how firms can learn through acquisitions (Nadolska & Barkema, 2014; Zollo & Singh, 2004). This research has emphasized that acquisitions can provide a "shock" to firms, facilitating transfer of knowledge and fostering exploration (Nadolska & Barkema, 2014), but that there are significant barriers to this transfer,

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which makes the integration process critical to realizing the potential inherent in acquisitions (Bresman, Birkinshaw, & Nobel, 1999; Vermeulen & Barkema, 2001). This research, however, has examined firm-level outcomes such as accounting return (Zollo & Singh, 2004) or survival of the merged entity (Vermeulen & Barkema, 2001), which are indirect indicators of knowledge transfer. We find support for the idea that acquisitions facilitate transfer of capabilities, and that the integration process matters, as changes in the operating personnel appear to accompany performance changes. We also find evidence for the existence of barriers to these transfers, as importing capabilities to incumbent facilities was impeded when the incumbents were in a different industry from the acquired facility.

For the broader literature on the performance consequences of asset sales, our research extends Maksimovic & Phillips, 2001 by employing a matching method to account for the endogenous choice process and by employing a new performance variable. By confirming their findings of a conditional location for performance change, our research suggests a way to reconcile divergent findings that have explored only performance changes among acquired units (Lichtenberg et al., 1987; Maksimovic & Phillips, 2001; McGuckin & Nguyen, 1995; Siegel & Simons, 2010). Our research shows that if differences in selling and buying firms are not taken into account, targets may improve, degrade or experience no change, exactly the pattern of results that have been reported. Thus, despite the difficulty of the effort, our research (along with that of Maksimovic & Phillips, 2001) suggests the need for more bi-directional studies.

For the literature on business and the environment, our work provides a double dividend by uncovering both further evidence of the existence of specialized environmental capabilities and new evidence that asset sales facilitate their transfer. Previous research on environmental capabilities has been impeded by the need to observe a capability "shock" that could be correlated with a change in performance. In other words, while prior work has demonstrated that environmental capabilities appear to be important (Berchicci et al., 2012; Christmann, 2000), it is difficult to identify these capabilities in action. By using asset sales from better and worse performing firms, we gain access to a potential capability "treatment." Then, by employing a number of methods to reduce bias from the non-randomness of the treatment, we are able to provide new evidence of the existence of environmental capabilities. This finding, moreover, provides important evidence for the role of corporate environmental strategy. Research has long demonstrated that firms differ in their environmental performance (Bansal, 2005; A. A. King & Lenox, 2001; Sharma, 2000), but there is relatively little evidence regarding how environmental issues might affect, or be affected by, corporate strategic decisions (Berchicci et al., 2012; Diestre & Rajagopolan, 2011). We demonstrate that asset sales are a mechanism by which corporations extend their environmental capabilities, or bring new capabilities into the fold.

Finally, our results speak to a central and longstanding debate over whether or not environmental performance is driven by a firm's "proclivity" to be environmental responsible or by a firm's "ability" to reduce waste and improve efficiency (see, e.g., Bansal & Roth, 2000; Berchicci & King, 2007; Hart, 1995; Sharma, 2000). We find a preponderance of evidence that suggests the ability story is dominant. The pattern of environmental change is consistent with the inference that acquisitions allow the transfer capabilities to locations where they are needed. We find no evidence that *on average* acquisitions tend to reduce environmental performance. Indeed, our results suggest that organizational forms designed to preserve social and environmental performance, such as the "Benefit Corporation" may have unintentional adverse consequences (see Stout, 2012 for discussion of these organizational forms). If the flow of environmental capabilities is indeed critical to performance improvement, protecting managers from acquisition through governance mechanisms or benefit corporation status may actually reduce environmental performance. Our analysis suggests that buffering firms from the market for corporate assets may also limit their access to the capabilities asset sales can provide.

There are several reasons to be cautious in generalizing from our findings. Our study is performed on only one indicator of environmental capabilities (toxic chemical waste); and it is conducted only in manufacturing in a highly regulated nation. Thus, we cannot claim that our results would hold for other measures of environmental performance or for other settings such as service industries. Furthermore, while we find evidence that acquisitions allow for transfer of environmental capabilities, we cannot disprove the idea that asset sales sometimes remove environmentally conscious managers from control.

Despite these limitations, our study provides important evidence of the role that corporate strategic decisions such as asset purchases and sales can play in environmental outcomes. The impact of these decisions is likely to become ever more important as firms and governments respond to growing environmental challenges. Private and public policies designed to maximize the value of these corporate changes will be critical in ensuing a smooth transition to a more environmentally protective economy. Our analysis provides some guidance, but future research should explore in more detail the mechanisms of change and the consequences of asset sales on environmental goods and services.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Table S1. Assessment of differences between treated and control firms after matching.
Table S2. Changes in waste generation in the year of the acquisition and the year after acquisition aggregated at the facility level.

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