A Couple of Spills a Year, That's Normal? Learning and Greenwashing in the Pipeline Industry

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Introduction

> In summary, there is no compelling evidence to reduce the frequency of spills because of modern materials and methods. The increased corrosiveness and erosiveness of the product being transported [by the Keystone XL Pipeline] will likely cancel any gains due to materials and methods improvements and soft technological safeguards will likely become less effective over time. (Stansbury 2011)

A graduate landing her first job in the pipeline industry in 2020 would have a very different experience than somebody who started in the year 2000. Pipeline operations are centralized in control centers. Employees control most functions of the lines on the computer, using mature software. When there are concerns about the safety of a line, rather than digging up the pipeline, the operator can send a so-called "smart pig" through it to check its condition. However, historical pipeline spill data tells a different picture. Crude oil pipelines have benefited from improved corrosion protection, but the safety performance of refined petroleum pipelines has stagnated. From the year 2000 to the year 2019, the spill volume has been consistently at a level of about 20 barrels spilled per billion barrel-miles transported (see Figure 1). Then what is all the rhetoric of technology, development, and learning from spills about?

Insert Figure 1 about here

This dissertation uses two lenses to analyze the phenomenon of pipeline safety: organizational learning and greenwashing. Organizational learning is a useful literature to shed light on how insights from pipeline spills affect the subsequent development of

technology and routines (Maslach, Branzei, Rerup, & Zbaracki 2018). However, the literature ceases to be useful where learning comes to halt, or where safety turns from something to be attained to something to be demonstrated to stakeholders and the regulator. Greenwashing allows us to examine this issue of deliberately misleading behavior (Lyon & Montgomery 2015). The first chapter engages the mainstream learning literature. The second chapter summarizes the different streams of the learning literature and argues that a less technocentric view could pave a way for overcoming limits of the literature and limits to learning alike. The third chapter uses the lense of greenwashing to highlight the toxic behavior at the other end of the spectrum–intentionally misleading communication.

The first chapter of this dissertation begins with an orthodox view of organizational learning. Organizational learning is a useful frame for analyzing the technological side of pipeline safety, and why certain safety improvements are attained. Qualitative data reveals the learning processes taking place within the industry. The usefulness of an orthodox theory of organizational learning ends where we can observe that learning continues, but no more improvements in pipeline safety are achieved (Figure 1). The learning literature predicts this bottoming out (Argote 2013), but does not address whether learning curves converge because learning stops, or for other reasons. This chapter examines the mechanisms behind safety improvements, the limits to learning, and the bottoming out of pipeline safety.

The second chapter raises the issue of validity in organizational learning (Rerup & Zbaracki 2020). The current consensus is that as organizations accumulate experience from performing a task, their performance increases (Argote & Miron-Spektor 2011). But, as demonstrated above, one can observe an accumulation of experience with a corresponding change in cognition–a process of organizational learning–without the accompanying change in performance. Outside the literature stream on *organizational knowledge* (Bingham & Eisenhardt 2011), authors emphasize the ambiguity of organizational experience (March 2010). This stream would contend that sometimes, to attain success, a substantial break

with precedent is necessary. This chapter reunites these two disparate streams of the organizational learning literature.

The third chapter discusses greenwashing as a reason why pipelines continue to fail. Despite March raising the issue of goals, coalitions, and politics in his early work (Cyert & March 1963), the topic is inexplicably absent from the current literature. Internal industry standards and company practice show that new insights are incorporated into practice. But the lived reality of incidents and spills is not what shapes communication with external stakeholders. Instead, in the classic greenwashing fashion, outside-facing documents are carefully crafted to convey an image of pipelines as safe and responsible, and catastrophic spills or near-spills not being the norm, but rare exceptions–the actors craft a public image (Lyon & Montgomery 2015). For instance, to obtain a permit for the construction of a new pipeline, a pipeline operator has to establish that the pipeline is safe. Similarly, support from the public and state governments requires for pipelines to be perceived as safe. The third chapter discusses how technologies can be used in greenwashing attempts to give an industry a modern, and safe image.

Studying pipeline spills as a way to study environmental impacts

This section lays out the motivation for studying the pipeline industry. The "gold standard" for sustainability research is to comprehensively measure environmental impacts. A common approach for doing so is to use ESG indicators. However, many barriers have to be overcome to make effective use of ESG indicators. Specifically, how the indicator is constructed has to be taken into consideration: the researcher has to be aware that the indicator is a product of social construction and has to treat it as such when conducting empirical research (Eccles, Lee, & Stroehle 2019). In particular, comparisons across industries are problematic. ESG indicators are always a combination of other metrics, and when for instance one of these metrics dominates the impact of an industry (e.g., downstream emissions of the fossil fuel industry), that should be taken into consideration

during research design. Data availability also tends to be better for large corporations, favoring a cross-industry approach over intra-industry tests.

Moving from an ESG indicator to a more specific metric means making a sacrifice. The researcher to some degree forgoes the aspiration to measure impacts comprehensively, and research may become susceptible to greenwashing. For example, a chemical producer might try to improve its image by improving worker conditions; to then make any generalized statements on the sustainability of the corporation's operations without also taking into account e.g., environmental emissions would draw a wrong picture. On the flip side, to judge chemical company with excessive deaths only by its environmental impacts would also be flawed. By focusing on just one issue these complexities are lost.

The only context where focusing on just one metric would be justified is when that metric represents the most important area of impact. Coal power plants for instance are characterized by the high number of respiratory problems and indirect deaths they cause through air pollution, and the nuclear industry by its catastrophic potential. For pipelines, the case is less clear, because of their role in the fossil fuel supply chain, and by extension global climate change. However, pipelines are not indispensable for the global fossil fuel. A large share of petroleum transport globally happens by ship, which is also very cost-efficient. Thus, the pipeline industry's environmental impact is largely characterized by pipeline spills, especially because of their catastrophic potential.

Because pipeline spills dominate the pipeline industry's environmental impact, we can use the spill data to generate insights on *organzational learning* and *greenwashing* that should hold even if we do not take other impacts into consideration. First, we will examine the limits to *organizational learning*. Individual oil spills are well documented, giving us access to the lessons to be learned from hundreds of events every year. In case of the most severe spills, where supposedly the largest amount of learning occurs (Madsen & Desai 2010), the spill causes and lessons learned are further spelled out in detailed reports by the National Transportation Safety Board (NTSB). Madsen (2009) carries out a similar

industry-wide study of organizational learning on fatal accidents in US coal mining. Madsen uses that context to extract evidence on organization-level learning from failure. The context of the pipeline industry allows us to expand on Madsen's work and also comment on the industry-wide convergence of learning (as evident from the normalized rate of spills). Further, the nature of the outcome variable (see previous paragraph) allows for a discussion at the intersection of corporate (environmental) sustainability and organizational learning (George, Schillebeeckx, & Liak 2015). In other words, this research allows for comments on some of the same processes that were discussed by Wright and Nyberg (2017) with regard to climate change being picked up by corporations but insufficiently tackled, albeit from from a slightly different, quantitative perspective. This perspective recognizes changes that have been made while acknowledging that pipeline spills remain to be an important environmental issue.

Greenwashing is the second area that pipeline spill data can shed light on. As hinted at above, greenwashing is difficult to capture because organizations are deliberately cultivating their image. Where greenwashing takes the shape of decoupling between internal action and communication with the environment (Lyon & Montgomery 2015), ESG indicators are also affected. Pipeline operators can misrepresent their efforts to improve pipeline safety, but pipeline spills are generally well documented. I probably don't have to remind the reader that oil in its crude form is a black, gooey substance. On waterways, refined oil forms distinct films. Both crude and refined oil give off a distinct odor. Pipeline spills are often initially discovered by residents. Emergency responders and specialized spill response staff as well as often journalists are all groups of people that would become aware of pipelines spills once they reach a certain scale. In short there are many reasons why pipeline spills are better documented than e.g., human rights violations or greenhouse gas emissions. For these reasons, we can identify well for the pipeline industry the organizations that communicate a commitment to pipeline safety but exhibit a poor safety performance. Because the datasets are longitudinal in nature and cover (at

least for pipeline miles and spills) the complete industry, it offers an opportunity to study the scope of greenwashing in an industry as well as its development over time.

As shown in this section, examining the pipeline industry provides a range of insights. These insights both take the form of contributions to theory development, and also allow us to take stock of an industry and its development over time. The second form of insight could become relevant for stakeholders, such as NGOs that monitor the pipeline or other industries. Real-world oriented questions that this research could shed light on are "what should stakeholders expect of polluting industries both in terms of cleanup and greenwashing?" Other questions, this research cannot answer, but give an impetus for an informed debate, e.g., "what level of spills is acceptable, and how do we get there?" Finally, while the fact that pipeline spills dominate the pipeline industry's environmental impacts is convenient for research, it may also represent a limitation. The complexity of managing multiple impacts at once compared to focusing only on one impact means that there might be different dynamics at play in the context of the pipeline industry compared to other, more complex industries.

Literatures

Greenwashing

Greenwashing describes a range of activities. This section provides three examples of greenwashing. This dissertation uses the third one, selective disclosure, which should be distinguished from the first two. The first, maybe the oldest one, describes an attempt of improving reputation through association with a signifier of ethics. For instance, "bluewashing" describes a corporation's effort to construe an association between a product and the United Nations (Laufer 2003). Similarly, in marketing greenwashing describes falsely advertising a product as environmentally friendly (Delmas & Burbano 2011). For that purpose, a corporation does not necessarily need to make false claim. It may be sufficient to use green packaging and images of flowers. Many consumers can also be

mislead with close-to-meaningless labels and certifications. Greenwashing has also long been a problem at the level of corporate governance (Ramus & Montiel 2005). With regard to environmental reporting, the term greenwashing as used in the literature often describes a process of selectively releasing positive information about one's environmental (or social) performance without also releasing negatives ones (Lyon & Maxwell 2011). That approach of selective disclosure is insidious, because the information released are objectively true, yet, the picture of reality they paint is not accurate. The approach is also suitable for empirical research on organizations. Marquis, Toffel, and Zhou (2016) for instance operationalizes greenwashing as the difference between what share of metrics of environmental performance a corporation discloses and what share of total impacts these disclosed emissions make up for. For example, a corporation that discloses nine out of ten of its emission types, but where the missing emission type makes up for 90% of its environmental impacts, would gain an abysmal score of $0.1 - 0.9 = -0.8$.

The abovementioned types of greenwashing have in common that none of the statements which organizations make are openly untrue, or even criminally liable. Note also that intent is not a necessary condition for greenwashing (although intent is often implied). For instance, Lyon and Maxwell (2011) point out that a firm might itself be uncertain of its environmental impacts (Lyon & Maxwell 2011, pp. 26f). More universally, greenwashing can be defined as "any communication that misleads people into adopting overly positive beliefs about an organization's environmental performance" (Lyon & Montgomery 2015, p. 225). Within that definition, greenwashing takes on different forms. Since misleading communication constitutes greenwashing regardless of intent, a discussion of motivations and mechanisms for greenwashing is optional in empirical works on the topic. That definition of greenwashing as misleading communication regardless of intent describes well the developments taking place in the pipeline industry. Although the qualitative data provides several examples that suggest malicious intent, the divergence between asserted and observed pipeline safety to some degree resides at the industry level

and is shared by all actors. The myth of pipelines as a safe technology is diffused at the population level by actors such as the American Petroleum Institute, the engineering profession, and shared technologies. The qualitative data allows us to make educated guesses as to the mechanisms at play at the different levels, but not to establish unambiguous intent and effect direction.

The divergence between communicated and observed pipeline safety amounts to more than just a decoupling process. The diffusion of pipeline technology ensures some coupling in the industry, and there is little evidence that technology is used throughout the industry in ways that it is not intended for. Decoupling does not equal greenwashing (Lyon & Montgomery 2015). For example, if sustainability is decoupled in an organization because the sustainability does not have sufficient resources to effectively implement initiatives, and the organization then announces a major initiative, this communication would then qualify as greenwashing. However, not all decoupled activities result specifically in greenwashing, and not all cases of greenwashing are the result of decoupling–as mentioned above, greenwashing can also be a deliberate, malicious strategy. Decoupling could occur in other areas, such as R&D activities, and greenwashing could result from other organizational processes, for example malice or misjudgment. This dissertation specifically discusses greenwashing that results from a technology that may function as designed, but does not deliver the results that it promises. Motives for greenwashing in this context vary. There are documents that are specifically written to testify that pipelines are safe to obtain permits (e.g., discussed in Stansbury 2011). But there are also grey areas, where financial interests and obligations to ensure pipeline safety are interweaved and cannot be disentangled. Decoupling certainly is not the encompassing or even dominant cause of cause of greenwashing in the pipeline industry.

The Green Black Gold Blues. Diffusion and proliferation of greenwashing in the pipeline industry

Many corporations engage in greenwashing. So what, one may say, there is always a competitor one can buy from. But not every industry has an incumbent that can be trusted to act responsible and whose products are widely available. Especially in concentrated industries, finding a "good egg" may be difficult. Greenwashing in these industries can become an issue that is pervasive, that is "part of the culture", and that is hard to eradicate. This research takes a look at one such industry where greenwashing is pervasive to understand how greenwashing spreads across this industry. From the pipeline industry, the this research generalizes to industry-wide diffusion and proliferation of greenwashing.

The existing literature discusses multiple different styles of greenwashing. Their commonality is that they encompass "any communication that misleads people into adopting overly positive beliefs about an organization's environmental performance" (Lyon & Montgomery 2015, p. 225). Selective disclosure describes a process whereby a corporation discloses favorable information about its environmental performance, whilst withholding negative information, to attain a positive image. When implemented correctly and in the absence of a harsh, reliable punishments for greenwashing the market may reward this behavior with a higher valuation (Lyon & Maxwell 2011). Usually, it is assumed that organizations greenwash to meet stakeholder expectations, to give the impression of transparency, or simply out of opportunism (Kim & Lyon 2015, Marquis et al. 2016). The definition of greenwashing does not prescribe a specific mechanism that would have to be at play for an activity to qualify as greenwashing.

Pipeline operators use often new and unproven technology to window dress their performance and gain permits for the construction of new pipelines. The operators advertise their use of technologies that are "safe"–that can be proven to fulfill their function in a lab setting or simulation–but that have not served to drive down the number or volume of oil spills since the turn of the millenium (see section "Introduction"). The reason

for this shortcoming is that these technologies do not address the causes of spills. We will denominate these technologies in this research as not issue-oriented. The industry maintains a strong claim to safety. Pipelines, unlike oil-by-rail, are asserted to be safe, by merit of the physical principles that they operate on. Further, modern technology, as employed to improve pipeline safety, is asserted to be perfectly controllable. Typically, greenwashing in the pipeline industry falls into the realm of nonmarket strategy. This becomes most obvious when documents are specifically written to obtain a permit or attain another goal. But greenwashing is also present on corporate websites, annual reports, and publications by industry associations like the American Petroleum Institute. These documents emphasize safety initiatives, and gloss over recent spills, or emphasize spill response and remediation efforts. This myth of safe and controllable pipeline technology has also allowed the pipeline industry to attain broad public and political support in many states.[1]

This research takes a longitudinal approach to greenwashing and draws on data for the period form 2002 to 2019 from multiple datasets to examine greenwashing in the pipeline industry. (1) The Pipeline and Hazardous Materials Safety Administration's (PHMSA) dataset on pipeline spills and (2) on pipeline miles operated by individual operators and their utilization allows for the identification of pipeline spills and their causes. (3) Documents by the American Petroleum Institute (API) and other industry-level actors allow us to monitor the emergence of new, non-substantive technologies that fall into the realm of pipeline safety, but do not address common causes of pipeline spills. (4) Public documents by pipeline operators, such as annual reports or dedicated safety reports show the diffusion of these technologies and their use for greenwashing. (5) Data on executives in the pipeline industry, obtained from BoardEx, reveal the web of connections along which rhetorics are diffused in the industry. Finally,

[1] In Louisiana for example, anybody who protests on or near pipelines faces up to five years in prison, hard labor, and a $1,000 fine. `https://www.propublica.org/article/how-louisiana-lawmakers-stop-residents-efforts-to-fight-big-oil-and-gas`, accessed 2020-08-19

(6) fines levied on pipeline operators by the PHMSA, (7) post-spill statements by pipeline operators, that reveal their rational and perceived errors (albeit only ex ante), and (8) accident reports by the National Transportation Safety Board (NTSB) allow us to qualitatively assess the divergence between technological developments and spill causes.

To demonstrate the degree of greenwashing in the pipeline industry, this research determines the degree to which pipeline operators' communication with the external environment is driven by industry-level trends rather than by the individual operators' recent spills. This empirical examination also gives us an understanding of how greenwashing can become commonplace in an industry. The discussion of technology that is not issue-oriented also draws attention to other forms of greenwashing that front technology but miss the issue at hand. Other example include fracking, carbon offset, and possibly carbon capture and storage. This research may also allow stakeholders and activists to better target more insidious forms of greenwashing.

Greenwashing in the pipeline industry

Greenwashing is quite common in the American pipeline industry, and the fossil fuel sector in general (Kassinis & Panayiotou 2018). The industry extensively uses the language of engineering in its rhetoric. Its communication with the outside environment is typically carried out by engineers (e.g., in feasibility studies or environmental impact analyses). American Petroleum Institute (API) engineers define standards and explores new technologies for pipeline operators. The API simultaneously lobbies against climate action. It is difficult for the "receiving side" of the communication to see through the greenwashing strategy of the pipeline industry, unless they also have specialized engineers at their disposal.[2] The challenge is not that the claims made by engineers in the pipeline industry are factually incorrect, but that they do not address the issues that most frequently lead to pipeline spills (e.g., they involve not issue-oriented technologies). The language of

[2] For a successful attempt, see e.g., Stansbury (2011).

engineering that documents are dressed in prevent most readers to get through to that issue

By taking advantage of the language of engineering, pipeline operators gain access to a wide array of greenwashing strategies. The obvious is a stated commitment to pipeline safety, dressed in the language of engineering, but without substantiating the action to be taken. In other cases, greenwashing takes a more insidious approach, wherein the language of engineering and pipeline safety will conceal the primacy of business interests. For instance, the language and engineering can be used to misrepresent investments with a financial interests as primarily motivated by safety, or to obtain objectively verifiable data that cannot be refuted by stakeholders that are laymen. The following are two examples: (1) after a 2010 oil spill that polluted the Kalamazoo River in Michigan, Enbridge agreed to spend at least $110 Million to improve pipeline safety.[3] Enbridge successfully translated this settlement into an investment by using the money to increase its pipeline capacity and transport more oil along the same route. The residents that had been affected by the spill lost out against Enbridge a second time: once again they had their lifes disrupted, this type by construction work in their backyard, sometimes on a very short notice. Enbridge successfully circumvented the need for an environmental impact assessment by replacing the pipeline in short sections.[4]

(2) In 2006, in a confidential document that was later leaked, a consulting company on behalf of the TransCanada Corporation made two claims. If the Keystone Pipeline was to be constructed the operator could using the latest technology detect a large spill in as little as 9 minutes, and any spill over 50 barrels would only occur once every seven years (DNV Consulting 2006). This claim was not testable at the time but did convince the regulator to greenlight the construction of the pipeline. The pipeline began operation in

[3] `https://archive.epa.gov/epa/newsreleases/united-states-enbridge-reach-177-million-settlement-after-2010-oil-spills-michigan-and.html`, accessed 2020-08-19.

[4] For brief summary of events, see `https://www.youtube.com/watch?v=IAR7z76KWj8`, accessed 2020-08-08.

2010, and as of 2020 had experienced 5 spills of over 50 barrels,[5] including one case where the spill continued for 20 minutes after the affected landowner who had discovered the spill had called in[6]. The problems of the Keystone Pipeline are symptomatic of spill detection technology: a sensitive system can detect small spills but will also produce many false positives. Thus, the real challenge is actually the far more complex one of managing the safety culture, since personnel can easily become desensitized by frequent false alarms and even safety drills.[7] For a discussion of the role of the consulting firm in misleading the regulator in that case, see Stansbury (2011).

Assessing greenwashing in the pipeline industry

In order to empirically assess greenwashing in the American pipeline industry, this research focuses on two kinds of greenwashing. The first is non-substantive promises made. These are commitments to pipeline safety without details on action, or without the organization following through. This version of greenwashing can be coded by hand, as long as comparable documents are available across time. The second aspect are technologies that are not issue-oriented. Referrals to these technologies, we can capture by using Natural Language Processing (NLP): either through keyword searches, or by utilizing topic modeling.

Since the quality of the text data will be the key to obtaining meaningful results, constructing a good sample is of the essence. A list of the largest pipeline operators can be extrapolated from the Pipeline and Hazardous Materials Safety Administration (PHMSA) dataset. To obtain good quality text data, my sampling strategy focuses on the largest players in the industry, and completeness across time. Where annual reports or similar

[5] See `http://boldnebraska.org/keystone-pipeline-spill-history/`, or `https://julianbarg.shinyapps.io/incident_dashboard/`, accessed 2020-08-08.

[6] `https://www.thedickinsonpress.com/business/energy-and-mining/4004561-5-years-after-spill-rancher-and-pipeline-junkie-still-has`, accessed 2020-08-08

[7] See e.g., `https://www.ntsb.gov/investigations/AccidentReports/Reports/PAR1201.pdf`, p. 101.

documents cannot be obtained from central sources such as Mergent Archives, the SEC, or `www.annualreports.com`, the documents are collected as much as possible by hand from corporate websites. For the empirical section of this research, the two different types of greenwashing (non-substantive and technology-based) are tracked across organizations and across time. We obtain evidence that teh communication does in fact constitute greenwashing by comparing the diffusion of technology in rhetorics with actual spill rates and volumes. The empirical test then shows that the communication with the external environment on pipeline safety is determined by networks of diffusion for greenwashing much more than by recent failure modes, by substantive safety issues that could be addressed. To show that mismatch between communication and issues, this research takes advantage of both non-substantive communication and of the different types of technologies that are applied but that are not issue-oriented. These types of greenwashing we can track across the company documents and industry-level documents, and compare that data to the network data available from BoardEx. The importance of industry-level actors comes even more into focus when we turn to instances of deregulation in Louisiana and Texas. These instances of deregulation should act as exogenous shocks for greenwashing. We can expect that following these exogenous shocks the share space given to technologies that are not issue-oriented or non-substantive communication should become even more widespread.

References

Argote, L. (2013). Organizational Learning Curves: An Overview. In *Organizational learning* (2nd ed., pp. 1–29). Boston, MA: Springer US. Retrieved from http://link.springer.com/10.1007/978-1-4614-5251-5_1 doi: 10.1007/978-1-4614-5251-5_1

Argote, L., & Miron-Spektor, E. (2011). Organizational Learning: From Experience to Knowledge. *Organization Science*, *22*(5), 1123–1137. Retrieved from http://pubsonline.informs.org/doi/abs/10.1287/orsc.1100.0621 doi: 10.1287/orsc.1100.0621

Bingham, C. B., & Eisenhardt, K. M. (2011, dec). Rational Heuristics: The 'Simple Rules' That Strategists Learn from Process Experience. *Strategic Management Journal*, *32*(13), 1437–1464. Retrieved from http://doi.wiley.com/10.1002/smj.965 doi: 10.1002/smj.965

Cyert, R. M., & March, J. G. (1963). *A Behavioral Theory of the Firm*. Englewood Cliffs, NJ: Prentice-Hall.

Delmas, M. A., & Burbano, V. C. (2011). The Drivers of Greenwashing. *California Management Review*, *54*(1), 64–87. Retrieved from http://journals.sagepub.com/doi/10.1525/cmr.2011.54.1.64 doi: 10.1525/cmr.2011.54.1.64

DNV Consulting. (2006). *Frequency-Volume Study of Keystone Pipeline: Report for TransCanada PipeLines Limited* (Tech. Rep.). Retrieved from https://puc.sd.gov/commission/dockets/HydrocarbonPipeline/2007/HP07-001/Disk/ExhibitC/1July06/RiskassessmentfiledJuly,2006/DNVFrequencyVolumeStudyAppendixA.pdf

Eccles, R. G., Lee, L.-E., & Stroehle, J. C. (2019). The Social Origins of ESG: An Analysis of Innovest and KLD. *Organization & Environment*, 1–22. Retrieved from http://journals.sagepub.com/doi/10.1177/1086026619888994 doi:

10.1177/1086026619888994

George, G., Schillebeeckx, S. J. D., & Liak, T. L. (2015). The Management of Natural Resources: An Overview and Research Agenda. *Academy of Management Journal*, *58*(6), 1595–1613. Retrieved from http://journals.aom.org/doi/10.5465/amj.2015.4006 doi: 10.5465/amj.2015.4006

Kassinis, G., & Panayiotou, A. (2018, mar). Visuality as Greenwashing: The Case of BP and Deepwater Horizon. *Organization & Environment*, *31*(1), 25–47. Retrieved from http://journals.sagepub.com/doi/10.1177/1086026616687014 doi: 10.1177/1086026616687014

Kim, E.-H., & Lyon, T. P. (2015). Greenwash vs. Brownwash: Exaggeration and Undue Modesty in Corporate Sustainability Disclosure. *Organization Science*, *26*(3), 705–723. Retrieved from http://pubsonline.informs.org/doi/10.1287/orsc.2014.0949 doi: 10.1287/orsc.2014.0949

Laufer, W. S. (2003). Social Accountability and Corporate Greenwashing. *Journal of Business Ethics*, *43*(3), 253–261. Retrieved from http://link.springer.com/10.1023/A:1022962719299 doi: 10.1023/A:1022962719299

Lyon, T. P., & Maxwell, J. W. (2011). Greenwash: Corporate Environmental Disclosure under Threat of Audit. *Journal of Economics & Management Strategy*, *20*(1), 3–41. Retrieved from http://doi.wiley.com/10.1111/j.1530-9134.2010.00282.x doi: 10.1111/j.1530-9134.2010.00282.x

Lyon, T. P., & Montgomery, A. W. (2015). The Means and End of Greenwash. *Organization & Environment*, *28*(2), 223–249. Retrieved from http://journals.sagepub.com/doi/10.1177/1086026615575332 doi: 10.1177/1086026615575332

Madsen, P. M. (2009, oct). These Lives Will Not Be Lost in Vain: Organizational Learning from Disaster in U.S. Coal Mining. *Organization Science*, *20*(5), 861–875. Retrieved from http://pubsonline.informs.org/doi/abs/10.1287/orsc.1080.0396 doi: 10.1287/orsc.1080.0396

Madsen, P. M., & Desai, V. (2010). Failing to Learn? The Effects of Failure and Success on Organizational Learning in the Global Orbital Launch Vehicle Industry. *Academy of Management Journal*, *53*(3), 451–476. Retrieved from http://amj.aom.org/cgi/doi/10.5465/AMJ.2010.51467631 doi: 10.5465/amj.2010.51467631

March, J. G. (2010). *The Ambiguities of Experience*. Ithaca and London: Cornell University Press.

Marquis, C., Toffel, M. W., & Zhou, Y. (2016). Scrutiny, Norms, and Selective Disclosure: A Global Study of Greenwashing. *Organization Science*, *27*(2), 483–504. Retrieved from http://pubsonline.informs.org/doi/10.1287/orsc.2015.1039 doi: 10.1287/orsc.2015.1039

Maslach, D., Branzei, O., Rerup, C., & Zbaracki, M. J. (2018). Noise as Signal in Learning from Rare Events. *Organization Science*, *29*(2), 225–246. Retrieved from http://pubsonline.informs.org/doi/10.1287/orsc.2017.1179 doi: 10.1287/orsc.2017.1179

Ramus, C. A., & Montiel, I. (2005). When Are Corporate Environmental Policies a Form of Greenwashing? *Business & Society*, *44*(4), 377–414. Retrieved from http://journals.sagepub.com/doi/10.1177/0007650305278120 doi: 10.1177/0007650305278120

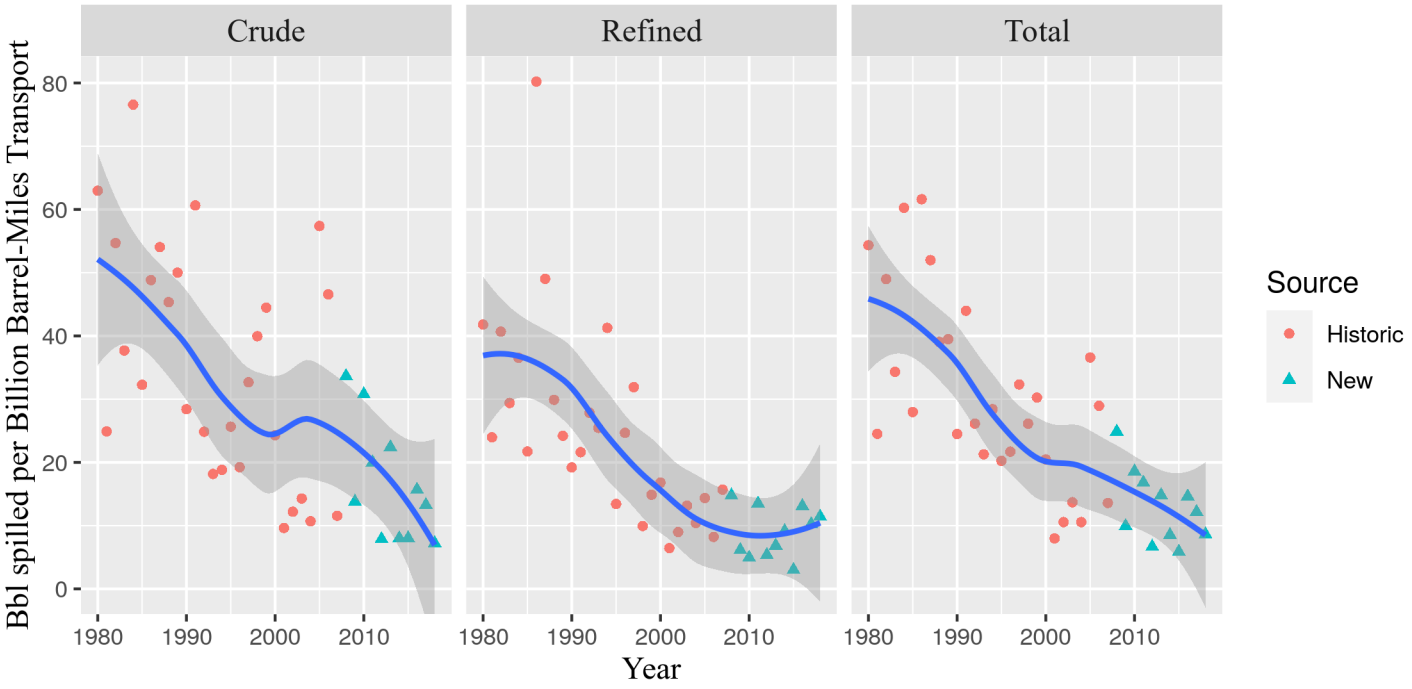
Rerup, C., & Zbaracki, M. J. (2020). *The Politics of Learning from Rare Events.*

Stansbury, J. (2011). *Analysis of Frequency, Magnitude and Consequence of Worst-Case Spills From the Proposed Keystone XL Pipeline* (Tech. Rep.). University of Nebraska–Lincoln Water Center. Retrieved from https://engineering.unl.edu/

downloads/civil/Worst-case-Keystone-spills-report-dis.pdf

Wright, C., & Nyberg, D. (2017). An Inconvenient Truth: How Organizations Translate Climate Change into Business as Usual. *Academy of Management Journal*, *60*(5), 1633–1661. Retrieved from http://amj.aom.org/cgi/doi/10.5465/amj.2015.0718http://journals.aom.org/doi/10.5465/amj.2015.0718 doi: 10.5465/amj.2015.0718

Figure 1. Pipeline safety improvements at the industry level



Blue line: Local regression (Loess), with confidence interval.

Source (new): https://github.com/julianbarg/oildata

Source (historic): http://www.api.org/environment-health-and-safety/clean-water/oil-spill-prevention-and-response/~/media/93371EDFB94C4B4D9C6BBC766F0C4A40.ashx, p. 38