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The Association between Mandated Environmental Liability Recognition and Voluntary ESG Disclosure Quality

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We examine the association between *mandated* Asset Retirement Obligations (ARO), i.e., environmental clean-up costs of normal operations estimated on the balance sheet, and the quality of *voluntary* ESG disclosures. We hypothesize that when firms recognize larger AROs with higher accuracy that this effort will spillover into enhanced voluntary disclosure of a broad range of ESG outcomes. Empirical evidence supports this hypothesis. In a sample of environmentally sensitive industries, we find that firms with larger and more accurate AROs exhibit higher ESG disclosure quality. In a changes analysis we find that increases in AROs map into increases in ESG disclosure quality. Further, we document predictable cross-sectional variation in the relation as a function of plausible mechanism variables. We provide DiD evidence as well as an instrumental variable analysis to address endogeneity. Our evidence suggests that accounting resources used to estimate mandatory ARO liabilities induce spillovers into improved voluntary ESG disclosure quality.

Keywords: Asset Retirement Obligations; AROs; Voluntary Disclosure; ESG; Environmental

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1. Introduction

Scholars and practitioners are increasingly interested in corporate actions and reporting related to environmental, social, and governance (ESG) matters. Christensen, Hail and Leuz [CHL] (2021) identify nearly 400 papers related to corporate social responsibility (CSR) – a concept used interchangeably with ESG. Yet, this remains a nascent scholarly field with more questions than answers. In this paper, we focus on one question at the center of the debate around ESG, namely how best to organize high quality ESG-related *disclosures*. Indeed, both research and practice note that a set of "best practices" for reporting on ESG has not yet evolved. In this setting, companies can exploit the lack of agreed upon disclosure standards and engage in "greenwashing" – i.e., making voluntary ESG claims without substantive efforts to support them (Crilly, Hansen, and Zollo 2016; Marquis, Toffel, and Zhou 2016).

Motivated by accounting theory, we ask whether the magnitude and accuracy of *mandatory* on-balance-sheet environmental liability estimates are associated with the quality of a firm's *voluntary* ESG-related disclosures. Our question on this association fits into an emerging body of scholarly research on ESG reporting at a time that practice on ESG disclosure is moving fast. The Center for Accounting Research and Education (CARE) conference in the fall of 2021, involving prominent accounting and finance practitioners and academics, was dedicated to this topic – with a special emphasis on climate related issues.[1] In that forum several practitioners advocated financial statement recognition of ESG costs or advocated for the incorporation of ESG costs directly into financial accounting numbers, such as via carbon-adjusted income accounts.[2]

Within this context of calls for firms going forward to *formally* recognize environmental externality costs into their financial statements, we focus on an under-researched area where companies *already* recognize ESG-related externalities. Specifically, we study *asset retirement*

[1] A recording of the conference can be viewed here: https://events.climateaction.org/care-conference/ .
[2] As an example, multinational food company Danone pioneered the use of carbon-adjusted EPS as a voluntary disclosure. Danone's focus on incorporating ESG issues into executive decision making was not without controversy, with some activist investors citing an overemphasis on such matters, ultimately costing the CEO his job (*Financial Times* 2021).

obligations (hereafter AROs) which consist of costs firms will incur when they take assets out of service – primarily assets with direct impact on the environment due to their nature of operations. Our research question asks whether ARO recognition by firms reveals information about their overall voluntary ESG disclosure strategy.

To make this connection, we build on accounting theory that posits a role for mandatory recognition to enhance the quality of voluntary disclosure (e.g., Gigler and Hemmer (1998); Stocken (2000); Lundholm (2003); Einhorn (2005); and Bertomeu, Vaysman, and Xue (2021)). Along these lines, we propose that a plausible indicator of the quality of voluntary disclosure regarding ESG activity is a firm's mandatory estimate of its normal environmental liabilities recognized on the balance sheet via AROs.

We adopt Bloomberg's rating of ESG disclosure quality as our main dependent variable. This is a well-accepted measure of the transparency with which a firm discloses its ESG endeavors as opposed to rating firms on the actions themselves (Ioannou and Serafeim 2019). We focus on this transparency aspect to gauge the quality of a firm's ESG disclosure strategy. To sharpen the power of our inferences, we also adopt Bloomberg's more specific environmental or "E" disclosure score as a second dependent variable, where it is available.

Our main treatment variables measure both the magnitude and accuracy of AROs on the balance sheet. AROs are environmental related costs that are paid at the end of the life of a productive asset. US GAAP requires firms to estimate a liability for such costs when it is clear that a firm is obligated to pay them upon retirement of the asset. These costs are particularly relevant in three industries that we analyze: mining; oil and gas; and utilities. When firms in these industries put assets into service, existing environmental laws enforced by the government ensure that the firms will absorb clean up costs when they retire the assets.

Motivated by the theoretical literature that predicts an interaction between mandatory and voluntary disclosure, we first explore whether a larger ARO liability is associated with higher ESG disclosure quality. We then ask whether more accurate ARO estimates are associated with higher

ESG disclosure quality. We measure the accuracy of ARO estimates using several proxies, including the magnitude of revisions to the liability during the life of the assets, as well as any loss recorded on the disposal.[3] As an additional proxy for ARO accuracy, we consider the discount rates that firms use to calculate AROs; distortion of these rates can inject bias in the present value of the accrual reported on the balance sheet.

Descriptive statistics show that when firms in our sample industries record an ARO this liability is material (on average 3.0% of total assets). Also, firms are more likely to underestimate than overestimate ARO liabilities. Specifically, 47% of firm-year observations show upward revisions of ARO liabilities due to changes in assumptions, while 23% exhibit downward revisions, and 30% make no change. The magnitude of these upward revisions is significant: an average value of 10.6% of the ARO liability.

We find that firms with larger ARO estimates receive higher rankings of Bloomberg ESG disclosure quality. Statistical and economic significance levels of the association are strong, suggesting that the transparent ARO accounting estimate provides relevant information about the quality of a company's ESG disclosures. We also observe a strong negative relation between losses on asset disposal and ESG disclosure quality. A loss on asset disposal captures a "settling up" effect for past AROs, reflecting consistently inaccurate ARO estimates. Our result thus shows that when a firm consistently under-provides for its ARO liability, it also provides less transparent ESG disclosures. We do not observe an association between discount rates and ESG disclosure quality.

To infer causality and address endogeneity concerns, we explore mechanisms for how ARO recognition could influence ESG reporting in four tests. First, we adopt a time series approach to analyze whether current changes in AROs influence concurrent and future changes in ESG disclosure quality. We find that an increase in the ARO liability in the current year drives an increase in ESG voluntary reporting quality both in the current and following year. This suggests

[3] The logic for the latter measure is that if the firm sells an asset with a significant *unrecorded* ARO liability, this will decrease the purchase price that a buyer of the asset is willing to pay, leading to a larger loss on disposal.

that additional investment in expertise for reporting of on-balance sheet environmental liabilities spills over into voluntary disclosure of broader ESG issues.

Second, we conduct cross-sectional analyses of the ARO-ESG disclosure quality relation to examine the role of several mechanisms leading to the spillover. We find that better resourced firms (captured by firm size and the use of GRI reporting), those with more relevant AROs (captured by the near-term settlement of the ARO and the environmental relevance of the firm's industry), those with higher market visibility (captured by analyst following and media attention), and those with higher financial reporting quality (captured by higher audit fees and lower discretionary accruals) exhibit a stronger ARO-ESG disclosure quality relation. These results are consistent with a spillover from financial reporting quality via AROs to voluntary ESG reporting.

Third, we exploit the introduction of a US Environmental Protection Agency rule on the disposal of coal combustion residuals (CCR) in 2015 to carry out a difference-in-differences analysis of the relation between ARO and ESG disclosures. This rule created a single standard for the operation and closure of impoundments (i.e., landfills holding waste) containing coal ash. As a result, many entities began accounting for AROs associated with coal ash for the first time (Deloitte Accounting Research Tool 2021). We limit our analysis to the utility industry and find that ESG disclosure improves after the introduction of the CCR rule for our treatment group of electric utilities, who constitute the majority of US coal consumption. Our control group of other utilities (e.g., water; gas) relying less on coal do not improve their voluntary ESG disclosure practices at the same rate. Also, we show that the change is larger for firms that report AROs.

Finally, we adopt a two-stage instrumental variable approach using the SEC's attention to ARO accounting as our instrument. In the first stage, we instrument the ARO liability with the count of the number of comment letters received from the SEC that specifically target ARO accounting and disclosure. In the second stage, we re-estimate our main regression with ESG disclosure quality as the dependent variable and the instrumented value of the ARO as our main

independent variable. We document a positive and significant association between the instrumented ARO value and ESG disclosure quality, consistent with our baseline results.

We contribute to an emerging field of research on ESG disclosure practice. The ARO estimate is a concise and transparent environmental accounting accrual included on the balance sheet. We document that this *quantitative* estimate is positively associated with the amorphous concept of ESG disclosure quality. Thus, the ARO estimate is a readily available statistic that allows a stakeholder to begin assessing a company's ESG disclosure quality – especially when a Bloomberg ESG disclosure rating does not exist.

In addition, our results suggest that firms can meaningfully estimate environmental liabilities that will be incurred far into the future. These fair value estimates of long-run future cash flows accruals on the balance sheet reveal information about other voluntary disclosures. Our finding suggests that firms could apply accrual accounting to other ESG measures that are currently left outside of the financial reporting process (e.g., environmental costs for reasons other than asset disposals, such as carbon consumption; or social commitments to housing and education in local communities). This is not just an academic argument. The FASB has proposed expanding the definition of ARO liabilities beyond legal requirements. Specifically, the FASB has proposed including the following language to ASC 410-20-25-4A:

> Obligations in the definition is broader than legal obligations. It is used with its usual general meaning to refer to duties imposed legally or socially; to that which one is bound to do by contract, promise, moral responsibility, and so forth (*Webster's New World Dictionary*, p. 981). It includes equitable and constructive obligations as well as legal obligations. (*FASB* 2019)

The language above is controversial, and comment letters from some Big Four accounting firms were not supportive. For example, KPMG stated:

> We believe that discussing obligations other than legal obligations is unnecessary and may create confusion (KPMG 2019)

This suggests that auditors and preparers see a narrow *legal* limit on the perspective firms must take when defining liabilities. This conflicts with a stakeholder model that advocates taking

into account obligations a firm owes a larger society – such as establishing a liability for carbon consumption or greenhouse gas emissions. Our research speaks to the current state of accounting, and whether estimated ARO liabilities relate positively with a firm's voluntary ESG disclosures.

We further contribute to the broad accounting literature and ESG research in particular with our novel analysis of the ARO liability. We demonstrate that this liability is economically meaningful to the financial position of many firms, as well as informative about ESG disclosure quality. To our knowledge ours is the first paper to explore this double role of the ARO liability.

Finally, our findings can serve as a guideline for the future work of the recently established International Sustainability Standards Board [ISSB], a companion Board to the IASB, under the umbrella of the IFRS Foundation. The ISSB will work in close cooperation with the IASB to ensure compatibility between IFRS Accounting Standards, that set out how a firm prepares its financial statements, and ISSB standards that will focus on disclosure of sustainability-related factors.[4] Our findings suggest that mandatory measurement of specific ESG-related issues in the financials can exhibit a positive spillover effect on the credibility of broader focus ESG disclosures by the firm, supporting the proposed cooperation between IASB and ISSB.

2. Hypothesis Development

2.1. Background

ESG is one of the more popular topics in contemporary management research, across virtually all business and economic disciplines. This research includes studies of actual firm ESG actions, valuation implications of such actions, as well as the public disclosure by firms of their actions and ESG-related outcomes. As noted previously, CHL (2021) cite nearly 400 papers in this space, and the list is growing. Our focus is on ESG-related disclosure. We adopt CHL's definition of [ESG] reporting as "the measurement, disclosure, and communication of information about

[4] See https://www.ifrs.org/about-us/who-we-are/

[ESG] and sustainability topics, including a firm's [ESG] activities, risk, and policies" (p. 1182). Perhaps because of the breadth of these activities no consensus exists on what constitutes quality ESG disclosures. In another review of the CSR literature Huang and Watson (2015) conclude that research has provided "little evidence on the determinants of disclosure quality" (p. 11).

Because ESG reporting is evolving, with attestation standards lagging behind, the threat of "cheap talk" or "greenwashing" by firms is a key concern. Managers may make vague and unverifiable comments – knowing that there is an outside interest in firms undertaking "green" and socially responsible actions (Marquis et al. 2016; Crilly et al. 2016). Moreover, stakeholders do not agree on what constitutes "good" ESG behavior. Chatterji, Durand, Levine, and Toubul (2016) focus on corporate social responsibility (CSR) ratings of actual activities and find a high level of disagreement in CSR ratings across six different independent agencies.

Previous accounting research on environmental liability recognition has focused on quantitative balance sheet accruals – but for major transgressions such as excess pollution (Peters and Romi 2013) or as a potentially responsible party to an EPA Superfund site (Barth, McNichols, and Wilson 1997). In contrast, Schneider, Michelon, and Paananen (2018) note that financial statements contain an on-balance-sheet estimate of certain environmental liabilities, the asset retirement obligation or ARO, that will be paid in the future and that are *not* related to extraordinary environmental disaster cleanups or polluting events. Both US GAAP and IFRS require recognition of the ARO, thus placing this recognized item in the intersection of ESG matters and existing financial accounting standards (FASB 2021).

Schneider et al. (2018) conclude that "disclosure practices on the implementation of accounting standards for environmental and social liabilities [is] a venue that has been under-investigated." We begin to fill this void by examining the relation between the magnitude and accuracy of the firm's mandated ARO accrual and the quality of its larger portfolio of voluntary ESG disclosures. Our goal is to assess whether this quantitative financial estimate of a particular environmental liability provides insight into the quality of overall ESG disclosure.

2.2. Accounting for Asset Retirement Obligations (AROs)

AROs are covered under Topic 410 of US GAAP's Accounting Standards Codification (ASC) system. The accounting and reporting for AROs were established in Statement of Financial Accounting Standards No. 143 (SFAS 143), effective in 2003. This standard was quickly supplemented with FASB Interpretation No. 47 (FIN 47), effective in 2005. SFAS 143 defines an ARO as "an obligation associated with the retirement of a long-lived asset." The standard requires that legal obligations associated with retiring an asset from normal operations must be recognized at fair value in the period the liability is incurred – which is considered as the time at which the asset is placed in service. The fair value estimate increases the book value of the asset in excess of its original price and is subsequently depreciated along with the rest of the asset. Over time the liability is increased, reversing the original present value discount. The discount rate used for these calculations reflects the project's own credit risk (i.e., in excess of the risk-free rate).

Addressing environmental liabilities was the FASB's intent when the project was initiated. In the *Background Information* section of SFAS 143 (Appendix B of SFAS 143), the FASB reveals that the original request of a guiding accounting standard came from the trade association representing electrical utilities – the Edison Electric Institute (EEI). The EEI and its constituent utility companies were concerned about how to better account for removal costs of their assets. The FASB responded to the EEI and engaged in discussions with that group along with representatives of the oil and gas industry, as well as the AICPA's Environmental Task Force (SFAS 143, paragraph B2). The examples provided by the FASB in SFAS 143 all pertain to environmental costs related to oil and gas, utilities, and natural resource firms. For example, Appendix C of SFAS 143 (*Illustrative Examples*) discusses accounting for retiring an offshore oil platform, decommissioning a nuclear plant, and reforesting land following timber operations.

As with any fair value based standard, firms face complexity when implementing ARO accounting. The firm needs to forecast costs that will be incurred decades into the future, while the state of clean-up technology will change. Moreover, environmental regulations are also subject

to change. FIN 47 was enacted two years after the original standard because the initial application of SFAS 143 varied significantly. The main issue that FIN 47 addressed was whether a firm should record an ARO if the retirement of the asset was conditional on the occurrence of another event(s). FIN 47 stated that the liability *should be* recorded, even if the conditional event is outside the firm's control. Prior to FIN 47 some firms were waiting for the resolution of the event, and therefore avoiding ARO recognition (Miller 2005). Appendix A of FIN 47 (*Illustrative Examples*) provides an example of a telecommunications firm that will incur environmental costs when they remove chemically treated wooden poles from the ground. Theoretically, the firm could leave the poles in the ground forever, as the hypothetical regulation only requires clean-up upon their removal. Yet practically, the firm should assume it will eventually replace the poles. Thus, despite the liability being conditional on this future event the ARO must be recorded (FIN 47 paragraph A5).

Figure 1 shows an example of an ARO disclosure for Chevron. The liability amount of $14.05 billion equals 5.6% of Chevron's total assets and 14.3% of their total liabilities. In accordance with GAAP requirements, the table indicates new liabilities, the settlement of old liabilities, accretion related to the unwinding of the discount, and revisions in the estimate. The text of the disclosure note shows that Chevron only accrues AROs for its "upstream" operations – the extraction of oil and gas from its properties. Chevron states that it does not record AROs for its "downstream" operations (e.g., refining crude oil; marketing refined products; etc.) as the retirement of such assets will be done at "indeterminate settlement dates." This example shows there is still much discretion as to the recording of such liabilities.[5]

We are unaware of academic accounting research that examines AROs. However, the media, investment professionals, and industry experts notice and discuss these liabilities. A recent *Bloomberg Green* article highlights the social risk imposed by Diversified Energy, a company that acquires marginally productive or inactive wells in hopes of extracting the remaining oil at a profit.

[5] Schneider et al. (2018) also note this disclosure by Chevron when highlighting the differences in accounting for AROs under US GAAP vs. IFRS (see p. 286).

The authors question whether sufficient ARO reserves have been accounted for to clean up the wells: "[a]t the rate Diversified is paying dividends, some worry there will be nothing left when the [environmental] bills come due" (Mider and Adams-Hand 2021). A recent *MarketLine* (2015) research report on Westar Energy notes in its SWOT analysis that the increasing ARO liability for the company is a weakness. Kaiser (2015a; 2015b) utilizes ARO disclosures to estimate decommissioning costs from an engineering perspective in the oil and gas industry.

In sum, ARO estimation is a non-trivial exercise, with management discretion and judgment permitting distortion of the true amount. Although no research has examined this accrual in the accounting field, these liabilities pose a financial risk to companies as well as an environmental risk to society. Our research is the first to study this accrual, and our question focuses on whether the on-balance sheet estimates of this discretionary environmental liability provide an indication of the quality of voluntary ESG disclosures.

2.3. Theoretical Linkage

Analytical research has established linkages between mandatory recognition rules and voluntary disclosure quality. For example, Gigler and Hemmer (1998) propose that, although mandatory disclosure of historical cost accounting is untimely in a valuation sense, such reports play a confirmatory role of past voluntary disclosures. Similarly, Lundholm (2003) develops a model where the credibility of "hard" information improves the value relevance of "soft" information. Einhorn (2005) predicts that mandatory disclosures will reduce the news threshold for when voluntary disclosures are made. Stocken (2000) demonstrates that in a repeated game, a periodic credible accounting report can discipline management into reporting truthfully in a "cheap talk" model. Finally, Bertomeu et al. (2021) discuss how efficiently designed mandatory disclosure policies are substitutes for excessive voluntary disclosures.

This line of theoretical research generally predicts that mandatory disclosures regarding value, even if untimely, can spur more informative voluntary disclosure. While this research therefore motivates our research question, one important difference exists between our setting of

interest and the ones studied in the analytical research: the ARO is a direct cash flow estimate, while in general ESG disclosures are not as they provide information on a broader set of measures (e.g., carbon emissions; water usage) that are not quantified in dollar amounts.

The Stocken (2000) framework is the most closely linked to our setting. In that model the disclosure is not characterized as a direct forecast of the cash flows of the firm, though there is assumed to be some relation between the economic earnings (ω) and the cheap-talk signal sent "good" (g) or "bad" (b). Analogous to our setting, ESG disclosures are not presumed to be direct forecasts of cash flow outcomes, but rather serve as a "cheap talk" proxy for a component which can be subject to limited *ex post* verification via the ARO accounting accrual.

Two other empirical studies rely on these theoretical models and provide supporting evidence on the interaction between mandatory and voluntary disclosures. Bischof and Daske (2013) conclude that European financial institutions subject to more stringent "stress test" disclosures during the 2008 financial crisis (a one-time mandatory disclosure) continue to provide high quality risk disclosures post-crisis when such disclosures are voluntary. Ball, Jayaraman, and Shivakumar (2012) study how increased investment in auditing financial statements (as captured by audit fees) is associated with more informative voluntary disclosure (as captured by management earnings forecasts). While they interpret their evidence to be consistent with the confirmation hypothesis that mandatory and voluntary disclosures are complements, the authors include a relevant caveat that:

> "Caution should be exercised in generalizing our results to other voluntary disclosures, particularly non-financial disclosures." (p. 137)

Therefore, in their view, it is an empirical issue whether we can document similar findings in settings such as ours with non-financial ESG disclosures.

In sum, both empirical papers above and the analytical work they rely on provide our motivation to examine whether properties of the mandatory ARO estimates are associated with the properties of voluntary ESG disclosures. We are unaware of any direct theory relating an

environmental accrual to broader ESG disclosures, yet this extant research cited above still provides a framework to motivate our hypotheses that follow.

2.4. Hypotheses

The previous discussion shows that accounting for AROs is a complex process, involving significant forecasting skills and knowledge of the regulatory environment. The analytical papers we cite further predict that a higher quality mandatory signal will lead to more informative voluntary disclosure. In our setting, we operationalize the quality of the mandatory signal by looking both at the magnitude and accuracy of the ARO liability.

We argue that, as the liability grows in magnitude, companies direct more resources towards environmental reporting, up to the point where the marginal cost of improving estimates outweighs the benefits of accuracy. As the ARO becomes larger, we expect the company has more resources to deploy towards tracking and reporting ESG activities as well – developing economies of scope in such reporting.[6] In addition, it is likely that as the ARO liability increases in magnitude, investors demand additional ESG voluntary disclosure, since they receive a larger quantitative estimate of environmental costs. As such, we expect that the quality of its voluntary ESG disclosures will improve along with the ARO magnitude. This leads to our first hypothesis:

H1: The magnitude of the ARO estimate is positively associated with the quality of ESG disclosures.

We also expect that as the firm applies more resources to estimate AROs their accuracy of measurement of the liability will improve. In line with our reasoning on the role of the magnitude of the ARO, we therefore expect that if ARO estimates are more accurate then there will be a spillover to the more general ESG disclosures that will be of higher disclosure quality.

H2: A more accurate estimate of the ARO liability is positively associated with the quality of ESG disclosures.

We define our accuracy variables more precisely in Section 3.3, yet briefly we introduce the

[6] As we discuss in Section 3.2 we deflate our measure of ARO by total assets such that the magnitude measure is relative to all other assets of the firm.

three measures here. First, SFAS 143 mandated a reconciliation each year of changes in the ARO estimate, including new liabilities incurred, the settlement of existing liabilities, and the revision of previous estimates. We use the revision as a percentage of the ARO balance to capture accuracy, as any revision suggests inaccuracy in earlier amounts. Second, when firms dispose of assets through the sale to a third party, we expect them to recognize larger losses if the ARO has been under-accrued. The purchaser of the asset (e.g., an underutilized oil property or mineral mine) will make their own forecast of retirement costs and bid down the purchase price if such costs are significant. Thus, a "settling up" of past under-estimates of the liability occurs via a loss on disposal. Finally, inaccurate ARO estimates can come from errors in the discount rate the firm uses to calculate the liability. In the pension accounting literature, research has identified discretion in discount rates as a vehicle for earnings management (Naughton 2019). In the ARO setting, firms account for their own risk profile when setting the discount rate. Therefore, larger deviations between the ARO discount rate and the firms' borrowing rates suggest greater inaccuracy in the liability estimate stemming from the discounting process.

To close our discussion of the hypotheses, we note that our primary analyses represent an association study. Yet, we believe our approach is a valuable addition to the literature given our lack of understanding of covariates to ESG disclosure quality. If we can identify a succinct on-balance sheet measure that provides information about the quality of ESG disclosures this can assist stakeholders as they interpret management qualitative discussions since norms of what is "good" disclosure are still being developed. This caveat notwithstanding, in Sections 4.3 and 4.4 we conduct several analyses to make causal inferences.

3. Research Design

3.1. Sample

We start our sample composition with all publicly traded US firms over the period 2012-2019. Although ARO reporting has been mandated since 2003, COMPUSTAT does not record

this liability as a separate field.[7] Therefore, we access the XBRL datasets provided by the SEC. XBRL reporting was mandatory for all firms by 2012, thus marking the beginning of our sample period. As we noted, demand for ARO standardization originated from industries with whom the FASB consulted to design the standard. We therefore focus our sample on these industries as they will likely exhibit AROs. Using the Global Industry Classification Standard (GICS), we focus on Energy (1010), Metals and Mining (151040), and Utilities (5510).[8] To make it to our final sample for hypothesis testing a firm must have: (1) non-zero and non-missing ARO liability; (2) a Bloomberg ESG rating; and (3) control variables from Compustat. Table 1 reports the results of our sample screen which yields 1,314 firm-years for our hypothesis tests.

Bloomberg rates firms on the quality and transparency of their ESG disclosures. However, this rating is not an assessment of how effective a firm is at attaining an underlying ESG performance goal. Rather, Bloomberg rates firms on how comprehensively they disclose their actions. We focus on a measure of the quality of ESG *disclosure*, rather than corporate actions as extant research documents inconsistencies across rating agencies in their assessments of relevant ESG performance (Chatterji et al. 2016).

Ioannou and Serafeim (2019) provide an overview of the Bloomberg disclosure measure and conclude that "Bloomberg has the widest coverage of all ESG datasets." They note that Bloomberg collects its data from publicly available sources and also industry-adjusts its scoring scheme so as not to penalize a company operating in an industry where a particular disclosure might not be relevant. The rating itself is a percentage score of the items disclosed out of the roughly 219 categories available (as noted, this denominator will vary by industry).

[7] Compustat does include a field titled *ACCRT – ARO Accretion Expense*. However, it does not report the liability itself. Moreover, we found *ACCRT* was often mis-reported, including listed as missing, when in fact a value could be found in the notes to the financial statements.

[8] Bhojraj, Lee, and Oler (2003) suggest that the GICS methodology provides superior grouping of firms into industries based on the comovements of several capital market outcome variables. The GICS methodology defines different levels of classifications, namely Sectors, Industry Groups, Industries and Sub-Industries. In our sample, "Metals and Mining" is a GICS "Industry", part of the "Materials" Sector (15) and "Materials" Industry Group (1510). We focus on the "Metals and Mining" Industry as we believe that other industries within the Materials Sector are less likely to face material AROs. "Utilities" and "Energy" are higher level Sectors and Industry Groups in and of themselves.

We reached out to Bloomberg to gain more insight into the descriptions from Ioannou and Serafeim (2019). Bloomberg confirmed the methodology, though they noted that as of 2021 they revised their score to focus on 122 data points. In Figure 2 we provide a screenshot of a portion of the disclosures used in 2021. Such details are not provided at the firm level, where only the aggregate score is presented. Bloomberg clarified that while they use webcrawlers to obtain ESG related information about firms, their analysts manually code the scores. Finally, we confirmed with Bloomberg that the mandatory ARO liability is *not* a component of the rating of voluntary disclosure. The focus of the Bloomberg score is on several non-financial ESG indicators as opposed to accounting accruals. Therefore, any association we document is not mechanical.

We utilize Bloomberg's ratings of both the broad set of ESG disclosures as well as only the environmental (*ENV*) component. The Bloomberg database sometimes only contains the *ESG* score and does not break out the components. For example, per Table 1 we have 1,314 firms with *ESG* scores, but only 934 (71%) have the *ENV* component. We discussed this difference in sample size with Bloomberg and they told us that when their automated search process cannot locate a summary report of environmental disclosures then they do not create an individual *ENV* disclosure score. Then, when they calculate the aggregate *ESG* score they consider the environmental component to be zero; hence there is a larger sample size for *ESG* vis-à-vis *ENV*.[9]

For our tests presented in the paper we use the Bloomberg scores as given. While the *ENV* is the more direct voluntary disclosure analogy to the ARO accrual, we also examine *ESG* for a broader look at how ARO recognition is associated with a more comprehensive measure of stakeholder driven disclosures, as well as to increase the sample size.[10]

[9] We independently reviewed the firm-years with an *ESG* score but missing an *ENV* score. There are 380 firm-years from 121 individual firms in this case. We reviewed their corporate websites and could locate only ten firm-years that included sustainability reports for three firms. Note that we searched in 2022, so it is possible that in the case where we located a report but Bloomberg did not, that the company had backfilled a previously hard copy report online such that it was impossible for Bloomberg to catch in the original year. Overall, we conclude that the inability of Bloomberg to locate a succinct set of environmental disclosures in a single report for these 380 firm-years appears reasonable.

[10] In untabulated tests we also assign a value of zero to *ENV* when Bloomberg does not report any value for that field and rerun all of our *ENV* tests on the larger sample. Results are generally stronger on this sample than the smaller sample of 934 firms reported in the tables with non-zero *ENV*. When these results are statistically different, we report

3.2. Determinants of Recording an ARO

Recording an ARO is a management choice, both in recognition and magnitude. Thus, before proceeding to our hypothesis tests where we predict that the ARO liability is associated with ESG disclosure quality, we first analyze potential determinants of ARO recognition. We measure two ARO variables in our tests: *ARO_IND* is a binary variable that indicates whether a firm records an ARO or not; *ARO_AT* is a continuous variable that captures the magnitude of the ARO scaled by total assets.

Next, we define the following determinants of ARO. First, we control for basic fundamentals that might be correlated with ARO: *SIZE* (logarithm of total assets); *ROA* (income before extraordinary items divided by total assets); *LEVERAGE* (total debt divided by total assets); *BTM* (book value of common equity divided by market value of common equity). We next control for firm and industry characteristics that might be directly related to the existence and magnitude of ARO: *PPE* (net property, plant and equipment divided by total assets); *AGE* (natural logarithm of fixed asset age); *FOREIGN* (indicator variable of operations outside US); *HIGHIMPACT* (identifier for industries directly involved with natural resource extraction or electricity generation); and *INNOVATION* (indicator if R&D expense is positive). To control for firms' general governance which could be related to managers' reporting behavior in general, we include *FORECAST* (indicator of management earnings forecast); *IO* (percentage of shares owned by institutional investors); and *BIG4* (indicator of Big 4 auditor). Since external pressure from the broader stakeholders could also drive managers' reporting behavior, we control for *VISIBLE* (indicator if the firm has received negative media coverage related to ESG activities). We further control for industry time-invariant characteristics and time trends by including industry and year fixed effects. The Appendix contains detailed definitions of all variables.

this in the text in the paper. We chose not to use this sample as our primary group for the *ENV* tests as we wanted to keep the Bloomberg data as given so that the results are more easily replicated.

Table 2, Panel A presents descriptive statistics of the variables we use in the determinants analysis using 2,988 firm-year observations from our selected industries with sufficient data on the explanatory variables. The descriptive statistics for *ARO_IND* and *ARO_AT* show that roughly 70% of the firm-years (2,087) report an ARO, while the average ARO is 3.2% of total assets. When we set *ARO_AT* to zero when a firm does not report an ARO, average *ARO_censored* becomes 2.2% of total assets. Table 2, Panel B reports the univariate differences in the determinants across the ARO vs. non-ARO groups. All variables point to differences between the two groups with ARO firms being larger with more *PPE*, among other different fundamentals.

Table 3 presents the determinants analyses. The specifications in the first two columns include the binary dependent ARO variable *ARO_IND*. Using a logit specification (1) and OLS (2), we find that the statistical results are very similar across these two models. Column (3) presents a Tobit model, utilizing *ARO_censored* as the dependent variable, the continuous variable *ARO_AT* presumed censored at zero.

Three variables are consistently significant across all three models. *ROA* obtains a negative coefficient, suggesting that firms with higher accounting returns are less likely to record AROs. *PPE* obtains a positive coefficient, consistent with fixed asset intensive firms being more likely to record AROs. This is intuitive since these obligations are tied to eventual asset retirements. *HIGHIMPACT* also obtains a positive coefficient across specifications. This is equally intuitive as *HIGHIMPACT* indicates industries that are most likely to incur environmental damage (e.g., oil, gas, or coal extraction) as opposed to industries that might offer support services (e.g., engineering consulting) or downstream activities (e.g., refining and marketing).

Overall, the models in Table 3 explain ARO occurrence and magnitude reasonably well, indicating that *ARO_AT* is not a randomly reported accounting accrual but a measure with economic meaning. To mitigate the correlated omitted variables problem in our hypothesis tests, we include variables identified as determinants in any of the models in Table 3 as controls when *ARO_AT* serves as the main treatment variable.

3.3. Hypothesis Testing

Our prediction in H1 is that the magnitude of the ARO liability is positively associated with ESG disclosure quality. To test this prediction, we estimate the following regression:

$$SCORE = a_0 + a_1 ARO\_AT + a_2' CONTROLS + \varepsilon \quad (1)$$

We evaluate H1 using two dependent variables capturing *SCORE*. *ESG* is the Bloomberg disclosure rating. The total *ESG* score captures various ESG aspects in addition to environmental considerations. We also use *ENV*, the Bloomberg score for only the environmental component of ESG, as a second dependent variable with arguably a closer connection with AROs.

ARO_AT is as defined before. We predict that α_1 will be greater than zero. The vector *CONTROLS* includes the variables from the earlier determinants models. We also include *ACCR_RATE*, the estimate of the discount rate used to calculate the present value of the ARO. We include industry and year fixed effects in the model, and cluster standard errors by firm when calculating t-statistics. We cannot use firm fixed effects given the unbalanced nature of the panel where several firms only appear once or twice in the sample due to limited Bloomberg coverage.

Our prediction in H2 is that accurate estimates of the ARO liability are positively associated with ESG disclosure quality. We estimate several OLS regressions to evaluate this hypothesis:

$$SCORE = \beta_0 + \beta_1 ARO\_AT + \beta_2 REVISE + \beta_3 REVISE\_SQD + \beta_4' CONTROLS + \varepsilon \quad (2)$$

$$SCORE = \beta_0 + \beta_1 ARO\_AT + \beta_2 ACCR\_DIFF + \beta_3' CONTROLS + \varepsilon \quad (3)$$

$$SCORE = \beta_0 + \beta_1 ARO\_AT + \beta_2 PPELOSS + \beta_3' CONTROLS + \varepsilon \quad (4)$$

$$SCORE = \beta_0 + \beta_1 ARO\_AT + \beta_2 REVISE + \beta_3 REVISE\_SQD + \beta_4 ACCR\_DIFF + \beta_5 PPELOSS + \beta_6' CONTROLS + \varepsilon \quad (5)$$

The dependent variable and initial treatment variable remain the same, as does the vector of controls, fixed effects, and standard error clustering approach. Each regression introduces a different estimate of accuracy, with the final model (5) including them all simultaneously. *REVISE* is the percentage change in the ARO liability during the year due to the change in assumptions about existing obligations. *REVISE_SQD* is the square of *REVISE* to account for any non-

linearities in the relationship. We allow for a non-linear relationship between *REVISE* and *ESG* as extreme values at either end of the distribution of revisions indicate noisy ARO estimates.[11] *ACCR_DIFF* is the difference between our estimates of the ARO accretion rate and the firm's borrowing rate on financial debt, with the latter defined as interest expense divided by debt. *PPELOSS* is an indicator variable with a value of one if the company disposed of fixed assets at a loss, zero otherwise. Since our accuracy proxies measure *inaccuracy*, we expect *negative* coefficients for each of these variables, while we expect the coefficient on *ARO_AT* to be positive.

4. Results

4.1. Descriptive Statistics

Table 4, Panel A includes distribution statistics for our main variables in the hypothesis test sample. First, the mean *ESG* score (26.3) is higher than the median score (19.2), suggesting right skewness in this variable (bounded between 0 and 100).[12] Further, there is significant variation in *ESG* scores (standard deviation of 15.6), which assists our empirical approach. We observe a similar distributional pattern for *ENV*.

Turning to the *ARO_AT* variable, the ARO liability is on average about 3% of total assets. In untabulated analysis we find that ARO is on average 13.3% of financial debt suggesting that ARO liabilities are important in our sample, although less so than financial debt. The panel also suggests that ARO liability revisions *REVISE* are positive on average, at 3.2% of the liability. Thus, initial estimates of the AROs are too low on average. *PPELOSS* reveals assets are sold at a loss in 15.8% of firm-years. The *ACCR_RATE* used to calculate the present values of the ARO

[11] Figure 3 illustrates what appears to be this empirical relationship: extreme revisions in the tails of the chart are associated with lower ESG and ENV disclosure scores.

[12] Mean ESG score in our US-based sample is also higher than in the sample from Ioannou and Serafeim (2019) that included companies from China, Denmark, Malaysia, and South Africa. Their mean ESG score is 20.0 with firms being included in the year when they adopt mandatory ESG reporting (see Figure I of their paper).

liabilities has a similar distribution as the firm's borrowing rate: the variable *ACCR_DIFF*, or the difference between these two rates, has a mean value of -0.7%.[13]

Table 4, Panel B provides descriptive statistics for firms within our industries (energy; metals and mining; and utilities) based on whether they record an ARO (included in our hypothesis tests) or not (excluded from our hypothesis tests). The ESG scores are significantly higher when the company records an ARO, consistent with H1. Results suggest that firms with AROs on average have an ESG score 8.2 points higher than those without this liability. This difference is statistically significant at the 1% level. This same result holds for *ENV*.[14]

Table 4, Panel C presents additional ARO liability revision statistics. Of 1,314 sample firm years, the most common revision is upward (622 firm-years or 47.3% of the sample). Downward revisions happen for 302 firm-years (23.0% of the sample) while 390 firm-years (29.7% of the sample) show no ARO liability revision. The magnitudes of the revisions appear large. On average, upward revisions are 10.6% of the ARO liability (median 6.7%) and higher in absolute value than downward revisions (average 7.9% or median 4.0% of the ARO liability).

As the first large sample study of AROs we present these novel descriptive statistics and conclude that the ARO is an important liability for firms in our sample industries. In addition, the ARO is systematically understated and corrected by future revisions.

Table 5, Panel A presents a correlation matrix for the sample used in our hypothesis tests. We note the strong positive correlation between *ESG* (1) and *SIZE* (9) (0.70). This result is consistent with past research on disclosure quality in general, and ESG disclosures in particular (Hahn and Kuhnen 2013). The magnitude of the correlation within our sample suggests that *SIZE*

[13] In untabulated tests we find that the correlation between the accretion rate and the borrowing rate is 0.22, significant at the 1% level. Two factors cause the correlation to be less than 1.0. First, we have to estimate each measure using financial statement data rather than observing a direct disclosure from the firm; this introduces measurement error. Second, these financial borrowings and ARO liability recognitions occur over several different years, and we do not expect that interest rates are intertemporally constant for our sample firms.

[14] In untabulated analyses, we compared Bloomberg ESG scores for a sample of firms from several other industries that are not ARO intensive. Due to Bloomberg data limitations at our institution, we were limited to 2,000 downloads per month. We randomly selected and downloaded 2,000 firms from outside our original industries and then kept only those industries where we had 100 or more observations. We find that these other industries have lower average ESG scores compared to our sample firms, underlining the importance of controlling for industry in our tests.

is a key control for our multivariate tests. We also observe that *ARO_AT* (3) is positively correlated with *ESG* (0.10 and statistically significant at the 1% level). At the same time, *ARO_AT* (2) is negatively correlated with *SIZE*, suggesting that as a firm grows in scale it takes on a different scope of activities where AROs become a less significant component of asset values.

Regarding our proxies for accuracy of *ARO_AT*, we do not observe significant univariate correlations between *ESG* and either *REVISE* (4) or *REVISE_SQD* (5). However, *PPELOSS* (7) is negatively associated with *ESG*, suggesting that firms that have sold fixed assets at a loss exhibit lower ESG disclosure quality. *ACCR_DIFF* (6) is positively associated with *ESG*. This positive correlation is inconsistent with our prediction in H2 if an ARO discount rate higher than a firm's borrowing rate leads to noisy ARO liability estimates. However, as many of these variables correlate significantly with *SIZE*, we need to evaluate associations in a multivariate framework.

4.2. Empirical Results of Hypothesis Tests

Table 5, Panels B and C, presents our OLS regression estimations of models (1) – (5) with *ESG* or *ENV* as the dependent variable. We include industry and year fixed effects and cluster standard errors at the firm level. Consistent with the prediction in H1, we observe a positive and significant coefficient on *ARO_AT* across all models in Panel B. This suggests that as more emphasis is placed on this environmental liability via on-balance sheet recognition the Bloomberg ESG disclosure quality rises. This is not a mechanical relationship since Bloomberg does not include the mandatory ARO estimate in the rating of voluntary ESG disclosure quality (see Section 3.1). This association in multivariate tests using the sample of firms that record AROs is consistent with the univariate analysis in Table 4, Panel B where firms with an ARO liability had significantly higher ESG scores than firms in the same industries that did not record AROs. In addition to being statistically significant, the *ARO_AT* coefficient is also economically meaningful. The average coefficient across all models is 46.4, so that a one standard deviation increase in *ARO_AT* is associated with an increased ESG score of 1.7, or roughly 6.5% of the unconditional mean per Table 4, Panel A (26.3).

We observe a similar result in Panel C when we use *ENV* as dependent variable: the coefficient on *ARO_AT* is positive and significant across all specifications. The coefficients on *ARO_AT* in Panel C are also more than twice the magnitude of the corresponding coefficients in Panel B, logically reflecting a stronger mapping of *ARO_AT* into *ENV*, the environmental subcomponent of *ESG*.

Next we evaluate the prediction of H2 in columns (2) – (5) of both Panels. The results show that only the occurrence of a loss on disposal of assets (*PPELOSS*) is negatively associated with *ESG*. While the magnitude of the coefficient on *PPELOSS* remains similar in Panel C, they are no longer significant at conventional levels.[15] While the scatter plot of *REVISE* and *ESG* in Figure 3 suggests the presence of a non-linear relation between both variables, we do not find significant coefficients on *REVISE_SQD* in either panel.[16]

Overall, our results suggest that the null hypothesis (H2) of no association between accuracy in the estimate of the ARO liability and *ESG* or *ENV* can be rejected when past under-reported AROs are settled up with low sales prices of assets upon disposal. The economic magnitude of this variable is significant. Because *PPELOSS* is an indicator variable, the magnitude of -1.6 suggests that when a loss occurs *ESG* falls by that amount, which is 6% of the unconditional mean. Again, we observe that the magnitude of the coefficient is larger in Panel C with *ENV* as the dependent variable, which is intuitive.[17]

4.3. Analyses of the Mechanism

[15] When we assign a value of zero to *ENV* to those firms missing this score and expand this sample then the *PPELOSS* variable is negative and significant at the 5% level.

[16] The coefficient on *REVISE_SQD* is negative in specifications that do not include industry fixed effects, suggesting the effect is confounded by industry factors.

[17] While the Bloomberg score is comprehensive, continuous, and independently measured, it is subject to the criticism that it includes too many inputs and uses arbitrary weights. Therefore, we test the robustness of our findings using an alternative measure of ESG disclosure quality as dependent variable: *TRR* is an indicator variable taking a value of one if Thomson Reuters codes the firm as having a separate ESG report, zero otherwise. As suggested by Dhaliwal, Li, Tsang, and Yang (2011), a firm's publication of a stand-alone ESG report signals a meaningful effort to improve the transparency of its disclosures in this area. While the sample size for these analyses is roughly cut in half, our untabulated results show a positive association between *ARO_AT* and this proxy for ESG disclosure quality. In addition, the association between the loss on disposal indicator variable, *PPELOSS* and *TRR* also remains negative and significant. These results support our initial conclusions for both H1 and H2 yet using an alternative dependent variable to the Bloomberg score.

While our finding that the ARO liability is significant in a regression on *ESG* or *ENV* is novel, it indicates association but not causality.[18] To further explore the mechanism behind our baseline findings, we carry out several additional analyses. In a *changes* test, we assume that if the investment in accounting and reporting technology for AROs spills over into improved voluntary ESG disclosures, then we expect significant increases in ARO recognition to predict increases in ESG disclosure scores in the future. Table 6 presents a lead-lag changes model where the dependent variable is Δ*ESG* (Δ*ENV*) measured contemporaneously or one year ahead (columns (1)-(2)). The main treatment variable is *ARO_UP*, an indicator variable equal to 1 if *ARO_AT* increases from year -1 to 0, and zero otherwise. Using change variables increases the data requirements for this test and thus reduces our sample size. We also include change specifications of relevant controls from Table 5, Panel B.

Results in Panels A and B show that *ARO_UP* in year 0 is positively associated with both Δ*ESG* or Δ*ENV* contemporaneously and one year ahead.[19] In terms of economic magnitude, we observe that in Panel A, a firm reporting an increase in ARO could expect an increase in their contemporaneous or one-year ahead ESG score of 0.4, which is 1.6% of its unconditional mean. The result is stronger for *ENV* in Panel B where we observe that an increase in ARO maps into a 3.2% (4.4%) increase in contemporaneous (one-year ahead) *ENV*.[20]

We also estimate a reverse specification to evaluate if an increase in *ESG* or *ENV* maps into a change in ARO contemporaneously and one-year ahead. Columns (3)-(4) show the results of this specification and indicate that this reverse association is not significant, providing evidence that the spillover happens from the measurement of ARO to the broader ESG disclosure rather than in the opposite direction.

[18] Our *PPELOSS* result variable does reflect changes (since the loss comes from a change in firm assets) but still provides only indirect evidence of causality.

[19] In untabulated analyses, we consider different specifications of *ARO_UP*. We observe that when the increase in ARO is relatively small this change maps into a lead change of *ESG* or *ENV*. However, when the increase in ARO is relatively large, the increase maps into an immediate contemporaneous change of both disclosure variables.

[20] When we assign a value zero to *ENV* for firms missing this score the t-statistic (1.50) on the coefficient for the contemporaneous change is not significant at conventional levels.

In a second test of the mechanism, we estimate cross-sectional levels regressions that include interactive variables that we predict will moderate the ARO-ESG disclosure quality relation in the spillover scenario. Table 7, Panels A and B present the results of specifications that examine four mechanisms.[21] Columns (1) and (2) consider 'resources' as a mechanism of spillover. Our proxies for resources are *SIZE* and *GRI*. *GRI* is an indicator variable equal to one if the firm prepares a sustainability report following GRI standards. Since the latter are a comprehensive set of sustainability reporting standards, we assume that the firm must devote substantial resources to preparing these reports. The results show that the coefficient on the interaction with *SIZE* is positive and significant in both Panel A and B. The coefficient on the interaction with *GRI* is only significant in Panel A when we focus on *ESG*, although it is significant in the Panel B specification when we replace the missing *ENV* values with zero (not tabulated).

Columns (3) and (4) consider 'relevance' variables, a concept we define to reflect the immediate importance of AROs. We adopt two variables as proxies for this concept. The first variable is *CURRENTRATIO*, measured as the fraction of current AROs to total AROs. The idea is that if ARO liabilities are relatively near-term they become more prominent for the firm as they exhibit cash flow effects in the nearer term. The second variable is the earlier defined *HIGHIMPACT*, reflecting a firm's direct involvement with natural resource extraction or electricity generation. We observe that the coefficients on the interactions with both variables are not significant in Panel A when we focus on ESG. By contrast, the coefficients on both interactions become significant in Panel B. In other words, the pattern suggests a spillover from AROs to *ENV* disclosure for those firms with relatively more important AROs.[22]

[21] To show the results in Table 7 we de-mean both *ARO_AT* and the various proxies of interest in this table and use the values relative to the center of the distribution. Thus, an 'average' firm will exhibit zero interaction coefficients while the reported coefficient on *ARO_AT* captures the main ARO-ESG disclosure quality association. This allows easy interpretation of the interaction coefficients.

[22] However, the results become insignificant when we include the missing *ENV* firms and code the variable as zero in those cases.

Columns (5) and (6) consider 'market visibility' variables to examine if this concept can act as a mechanism to conduct spillover from ARO measurement into voluntary *ESG* or *ENV* disclosures. We consider two variables to gauge market visibility. The first variable is *ANALYST*, reflecting the number of sell-side analysts covering the firm. The second variable is the earlier defined *VISIBLE* variable that captures TR's controversy score. Both panels show strongly positive and significant coefficients on both interaction variables.

Finally, we include two reporting quality variables, the log of audit fees (*AUDITFEE*) and discretionary accruals estimated via the modified-Jones model using industry regressions (*DA*). Our predictions are that ARO recognition will have a stronger effect on ESG disclosure quality when audit fees are high and discretionary accruals are low. The results are consistent with these predictions, except for *DA* in the *ENV* regression of panel B; the sign is negative but the t-statistic is not significant – although it does obtain significance when zero is imputed to the missing *ENV* firms and the sample size expanded (not tabulated).

In sum, the results across the tests presented in Table 8 show evidence of four potential mechanisms to explain the positive association between AROs and both *ESG* or *ENV*. Together, our results are consistent with a spillover taking place from the investments made in better estimating mandatory reported AROs into improved voluntary ESG disclosure quality.

4.4. Addressing Endogeneity and Identification Concerns

Our last set of tests address endogeneity and identification concerns. First, we exploit the introduction of an Environmental Protection Agency (EPA) rule on the disposal of coal combustion residuals (CCR) as solid waste in 2015 to carry out a difference-in-differences analysis of the relation between ARO and ESG disclosures. This CCR rule created a single standard for the operation and closure of impoundments (i.e., land fills) containing coal ash. In states where no regulation existed before, the new rule created a retirement obligation under the federal EPA regime. Many entities began accounting for AROs associated with coal ash for the first time (Deloitte Accounting Research Tool 2021).

We carry out the test by splitting our sample into a pre- and post-period; the former comprises all observations before 2015 given the rule's effective date. We further limit our analysis to the Utility industry. We do so since the US Energy Information Administration reports that the electric power sector has accounted for the majority of US coal consumption since 1961.[23] To design our test, we further limit the sample to firms with firm-year observations both in the pre- and post-period (i.e., before and after 2015).[24] A treatment firm is a utility firm in the following GICS industries: 551010 (Electric Utilities), 551030 (Multi-Utilities), and 551050 (Independent Power and Renewable electricity Producers). Control firms are the Gas and Water Utilities.

In untabulated analyses, we observe that *ARO_AT* increases for our treatment firms, but not our control firms, suggesting that the CCR rule is a 'valid' shock to treatment firms. Table 8 shows the results of our DiD test. Columns (1) and (2) show that *ESG* increases more in the treatment group post-implementation of the CCR rule. While the coefficient on *Treat*×*Post* is of similar magnitude in the *ENV* specification in Column (2), it is not significant at conventional levels – although it is significant if we replace the missing *ENV* values with zero (not tabulated). To evaluate the role of ARO reporting, columns (3) and (4) evaluate the interaction of treatment with the presence of ARO (*ARO_IND*). The results in both columns show positive coefficients on the interaction terms, providing support that treatment firms with AROs improve their voluntary ESG disclosure more post the implementation of the CCR rule.[25]

Second, we use an instrumental variable to capture variation in ARO reporting quality not associated with other omitted variables. Specifically, we use SEC comment letters received by a firm at any time during our sample period as an instrument for the *lack of quality* of ARO reporting.

[23] See https://www.eia.gov/energyexplained/coal/use-of-coal.php. In 2020, electric power accounted for 91.5% of US coal consumption. By focusing our analysis on this industry, we observe the behavior of the most important consumer of coal while eliminating noise from including different industries in the analysis.

[24] Our results remain qualitatively unchanged if we include observations from 2015 or not as treatment cases.

[25] As the DiD research design relies on a parallel trend, we test this assumption by examining the difference between the control and treatment firms' ESG reporting year by year across our whole sample period (untabulated). We use 2014 as the base to examine the coefficients year by year. We find that the coefficients are not significant prior to 2014, then become significant in 2016 following adoption of the CCR rule, before falling off again in 2019.

To meet the exclusion criterion with our instrument, we select comment letters that refer solely to ARO issues and reflect the SEC's concerns with ARO recognition and/or disclosure. In our first-stage estimation in Table 9, column (1) the variable *COMMENT* captures the total number of rounds of correspondence that a firm experiences with the SEC, and *ARO_AT* is the dependent variable. All other explanatory variables are those used in Table 5, Panel B as predictors of *ESG* (with the exception of *ARO_AT* which is now the dependent variable). The results show that increased correspondence with the SEC is negatively and significantly associated with the recognition of *ARO_AT*. The underidentification test suggests that the instrumental variable is relevant to our main variable of interest *ARO_AT*. The weak instrumental variable test further rejects the null hypothesis (F statistics 16.914).

In Column (2) we present the *ESG* regression using *Predicted ARO_AT* as the instrumental variable and find a positive and significant coefficient on this variable, consistent with earlier tests. However, the *PPELOSS* variable is no longer significant in this specification. Also, when we estimate these specifications using *ENV* as the dependent variable, the instrument becomes too weak, although this is reversed when we code the missing *ENV* values with zero and obtain results similar to the *ESG* variable (not tabulated).[26]

Taken together, the results of both tests in this section provide evidence that we can identify that accounting resources used to estimate AROs with greater accuracy induce spillovers into improved ESG disclosure quality.

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We estimate two additional untabulated tests. First, as suggested by Larcker and Rusticus (2010), we perform an Impact Threshold for a Confounding Variable test. The results suggest that to invalidate the main relationship between *ARO_AT* and *ESG*, 65.11% of the estimate would have to be due to bias, which we believe is not highly plausible. Alternatively, the omitted variable would have to be correlated at 0.326 with the outcome and at 0.326 with the predictor of interest. Second, we estimate a Heckman selection model (Heckman 1978) to control for selection bias. In the first stage of the selection equation, we include all determinants variables and the industry indicator variables. In the second stage of the outcome equation, we include all variables used in Table 6 except for *INNOVATION*, which appears to drive the selection of ARO reporting but is not related to ESG disclosure. After controlling for selection bias, the results remain qualitatively very similar as the main results reported in Table 6. Untabulated results suggest that the coefficient for *ARO_AT* is 50.897 (p value < 0.01). Similarly, the coefficient for *PPELOSS* is -1.534 (p value < 0.05). Finally, the inverse Mills Ratio is statistically significant.

5. Conclusion

Corporate ESG issues are a pervasive topic of modern management spawning many questions. In this paper, we focus on one such question: *what drives the disclosure quality of ESG reporting*? Relying on accounting theory, we propose that the quality of mandatory environmental accounting can act as a mechanism to influence voluntary ESG disclosure quality. Overall, our findings suggest that the magnitude and accuracy of the asset retirement obligation, an on-balance-sheet recognition of a mandatory environmental liability, is a clear and useful statistic that reveals how transparent firms are with other ESG disclosures.

Our findings thus speak to two important debates on current ESG disclosure practice. First, our evidence pertains to the debate on measurability of ESG issues such as environmental liabilities that will occur far into the future. We find that the mandatory fair value estimate that firms report for environmental liabilities related to asset retirements reveals information not just about the financial implications of this transaction, but also about broader ESG disclosure. Second, our evidence suggests that mandatory recognition of environmental liabilities is associated with the quality of voluntary ESG disclosures. This is important given the lack of a unifying theory or agreement on how to promote quality ESG disclosure behavior by corporations.

Recent evidence in Bochkay, Hales, and Serafeim (2021) shows how the development of voluntary disclosure standards promotes increased disclosure by firms on sustainability issues. Our findings complement this evidence by showing a link between mandatory accounting requirements and the *transparency* of broader voluntary ESG disclosures. Our evidence thus provides supportive evidence for the proposed cooperation between the IASB, with its focus on how firms prepare mandated financial statements, and the ISSB that will focus on developing disclosure standards of sustainability-related factors.

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Appendix. VARIABLE DEFINITIONS

Variables	Definition
ARO variables:	
ARO_AT	ARO liability divided by total assets (source: XBRL filing)
ARO_IND	Indicator variable which equals 1 if a firm reports ARO liability in a given year, 0 otherwise (source: XBRL filing)
ARO_censored	Left-censored ARO liability which equals 0 when ARO liability is not reported, otherwise equals ARO_AT (source: XBRL filing)
REVISE	Revision in ARO liability divided by ARO liability (source: XBRL filing)
REVISE_SQD	Square of REVISE (source: XBRL filing)
ACCR_RATE	Accretion expense divided by ARO liability (source: XBRL filing)
ACCR_DIFF	Difference between accretion rate and borrowing rate; borrowing rate is interest expense divided by debt (source: XBRL filing for accretion and COMPUSTAT for interest and debt)
PPELOSS	Indicator variable which equals 1 if loss incurred on PPE disposal, 0 otherwise (source: COMPUSTAT)
ESG disclosure variables:	
ESG	Bloomberg ESG disclosure score (source: Bloomberg)
ENV	Bloomberg Environmental disclosure score (source: Bloomberg)
TRR	Indicator variable which equals 1 if a firm issues a stand-alone ESG report, 0 otherwise (source: Thomson Reuters Refinitive)
Control variables:	
SIZE	Natural logarithm of total assets (source: COMPUSTAT)
ROA	Income before extraordinary items scaled by total assets (source: COMPUSTAT)
LEVERAGE	Total of debt scaled by total assets (source: COMPUSTAT)
BTM	Book value of common equity scaled by market value of common equity (source: COMPUSTAT)
PPE	PPE net scaled by total assets (source: COMPUSTAT)
AGE	Natural logarithm of fixed assets age, calculated as the accumulated depreciation divided by depreciation expense (source: COMPUSTAT)
FOREIGN	Indicator variable which equals 1 if a firm has operations outside of US, 0 otherwise (source: COMPUSTAT)
HIGHIMPACT	Indicator variable which equals 1 if the business activity falls under oil exploration and production ('10102010','10102020','10102050'), Electric utilities and multi utilities ('55101010','55103010'), and all the metals mining (151040) (source: COMPUSTAT)
FORECAST	Indicator variable which equals 1 if management issues guidance in a given year, 0 otherwise (source: I/B/E/S)
IO	Institutional ownership calculated as the percentage of outstanding shares owned by institutional investors, multiplied by 100 (source: Thomson Reuters 13f)
BIG4	Indicator variable which equals 1 if firm uses Big 4 auditor, 0 otherwise (source: Audit Analytics)
INNOVATION	Indicator variable which equals 1 if a firm reports R&D expense in a given year, 0 otherwise (source: COMPUSTAT)

VISIBLE	Indicator variable which equals 1 if a firm has negative media coverage on ESG issues in the most recent three years, 0 otherwise. Negative media coverage is identified if Thomson Reuters ESG controversy score leads to a downward adjustment of the ESG performance score (source: Thomson Reuters Refinitive)
Change variables:	
Δ*X*	Change of variable X from prior year
Δ*ESG*	Change of Bloomberg ESG disclosure, contemporaneous
Δ*ESG1*	Change of Bloomberg ESG disclosure score, one-year lead
Δ*ENV*	Change of Bloomberg ENV disclosure, contemporaneous
Δ*ENV1*	Change of Bloomberg ENV disclosure score, one-year lead
Δ*ARO*	Change of ARO_AT, contemporaneous
Δ*ARO1*	Change of ARO_AT, one-year lead
ARO_UP	Indicator variable which equals 1 if ARO is increased from the prior year, 0 otherwise
ESG_UP	Indicator variable which equals 1 if ESG score is increased from the prior year, 0 otherwise
ENV_UP	Indicator variable which equals 1 if ENV score is increased from the prior year, 0 otherwise
Others:	
GRI	Indicator variable which equals 1 if a company has followed GRI guideline within the sample period, 0 otherwise (source: Thomson Reuters Refinitive)
CURRENTRATIO	The proportion of reported current ARO computed as *Current ARO/Total ARO*
ANALYST	Natural logarithm of the number of analyst following (plus one) (source: I/B/E/S)
AUDITFEE	Natural logarithm of audit fee (source: Audit Analytics)
DA	Decile ranking of discretionary accrual measured by modified Jones model (Dechow et al., 1995)
Treat×Post	Indicator variable which equals 1 if a firm is in the following industries 551010, 551030,551050, and the year is post 2015 (including 2015)
COMMENT	Total rounds of correspondence to SEC comment letters on ARO-only issues (source: Audit Analytics)

Figure 1
CHEVRON – EXCERPT FROM 2018 ANNUAL REPORT

Note 24
Asset Retirement Obligations

The company records the fair value of a liability for an asset retirement obligation (ARO) both as an asset and a liability when there is a legal obligation associated with the retirement of a tangible long-lived asset and the liability can be reasonably estimated. The legal obligation to perform the asset retirement activity is unconditional, even though uncertainty may exist about the timing and/or method of settlement that may be beyond the company's control. This uncertainty about the timing and/or method of settlement is factored into the measurement of the liability when sufficient information exists to reasonably estimate fair value. Recognition of the ARO includes: (1) the present value of a liability and offsetting asset, (2) the subsequent accretion of that liability and depreciation of the asset, and (3) the periodic review of the ARO liability estimates and discount rates.

AROs are primarily recorded for the company's crude oil and natural gas producing assets. No significant AROs associated with any legal obligations to retire downstream long-lived assets have been recognized, as indeterminate settlement dates for the asset retirements prevent estimation of the fair value of the associated ARO. The company performs periodic reviews of its downstream long-lived assets for any changes in facts and circumstances that might require recognition of a retirement obligation.

The following table indicates the changes to the company's before-tax asset retirement obligations in 2018, 2017 and 2016:

	2018	2017	2016
Balance at January 1	**$ 14,214**	$ 14,243	$ 15,642
Liabilities incurred	**96**	684	204
Liabilities settled	**(830)**	(1,721)	(1,658)
Accretion expense	**654**	668	749
Revisions in estimated cash flows	**(84)**	340	(694)
Balance at December 31	**$ 14,050**	$ 14,214	$ 14,243

In the table above, the amount associated with "Revisions in estimated cash flows" in 2018 reflects decreased cost estimates to abandon wells, equipment and facilities. The long-term portion of the $14,050 balance at the end of 2018 was $12,957.

Figure 2
EXCERPT FROM BLOOMBERG ESG DISCLOSURE RATING MANUAL

Pillar (Weight)	Topic	Field ID	Field Description	Units	Disclosure Frequency	In Old Disclosure Score?	Weight (% of Overall Score Weight)
Environmental (33%)	**Air Quality**		**Air Quality Disclosure Score**	**Percentage**			**4.78%**
		ES007	Nitrogen Oxide Emissions	Thousand Metric Tonnes	Annual	Y	0.96%
		ES009	VOC Emissions	Thousand Metric Tonnes	Annual	Y	0.96%
		ES010	Carbon Monoxide Emissions	Thousand Metric Tonnes	Annual	Y	0.96%
		ES013	Particulate Emissions	Thousand Metric Tonnes	Annual	Y	0.96%
		F0949	Sulphur Dioxide / Sulphur Oxide Emissions	Thousand Metric Tonnes	Annual	N	0.96%
	Climate Change		**Climate Change Disclosure Score**	**Percentage**			**4.70%**
		ES036	Emissions Reduction Initiatives	Y/N	Annual	Y	0.11%
		ES071	Climate Change Policy	Y/N	Annual	Y	0.11%
		ES105	Climate Change Opportunities Discussed	Y/N	Annual	Y	0.11%
		ES106	Risks of Climate Change Discussed	Y/N	Annual	Y	0.11%
		ES001	Direct CO2 Emissions	Thousand Metric Tonnes	Annual	Y	0.47%
		ES002	Indirect CO2 Emissions	Thousand Metric Tonnes	Annual	Y	0.47%
		ES012	ODS Emissions	Thousand Metric Tonnes	Annual	Y	0.47%
		ES076	GHG Scope 1	Thousand Metric Tonnes CO2e	Annual	Y	0.47%
		ES077	GHG Scope 2	Thousand Metric Tonnes CO2e	Annual	Y	0.47%
		ES078	GHG Scope 3	Thousand Metric Tonnes CO2e	Annual	Y	0.47%
		ES255	Scope 2 Market Based GHG Emissions	Thousand Metric Tonnes CO2e	Annual	N	0.47%
		ES262	Scope of Disclosure	Nominal (1-3)	Annual	N	0.47%
		ES399	Carbon per Unit of Production	Metric Tonnes/Unit of Production	Annual	N	0.47%
	Ecological & Biodiversity Impacts		**Ecological & Biodiversity Impacts Disclosure Score**	**Percentage**			**4.79%**
		ES088	Biodiversity Policy	Y/N	Annual	Y	0.28%
		ES032	Number of Environmental Fines	Count	Annual	Y	1.13%
		ES033	Environmental Fines (Amount)	Million Reporting Currency	Annual	Y	1.13%
		SA231	Number of Significant Environmental Fines	Count	Annual	N	1.13%
		SA359	Amount of Significant Environmental Fines	Million Reporting Currency	Annual	N	1.13%
	Energy		**Energy Disclosure Score**	**Percentage**			**4.73%**
		ES035	Energy Efficiency Policy	Y/N	Annual	Y	0.14%
		ES014	Total Energy Consumption	Thousand Megawatt Hours	Annual	Y	0.57%
		ES015	Renewable Energy Use	Thousand Megawatt Hours	Annual	Y	0.57%
		ES080	Electricity Used	Thousand Megawatt Hours	Annual	Y	0.57%
		ES107	Fuel Used - Coal/Lignite	Thousand Metric Tonnes	Annual	Y	0.57%
		ES108	Fuel Used - Natural Gas	Thousand Cubic Meters	Annual	Y	0.57%
		ES109	Fuel Used - Crude Oil/Diesel	Thousand Cubic Meters	Annual	Y	0.57%
		ES384	Self Generated Renewable Electricity	Thousand Megawatt Hours	Annual	N	0.57%
		ES494	Energy Per Unit of Production	Megawatt Hours/Unit of Production	Annual	N	0.57%
	Materials & Waste		**Materials & Waste Disclosure Score**	**Percentage**			**4.74%**
		ES039	Waste Reduction Policy	Y/N	Annual	Y	0.16%
		ES019	Hazardous Waste	Thousand Metric Tonnes	Annual	Y	0.65%
		ES020	Total Waste	Thousand Metric Tonnes	Annual	Y	0.65%
		ES021	Waste Recycled	Thousand Metric Tonnes	Annual	Y	0.65%
		ES025	Raw Materials Used	Thousand Metric Tonnes	Annual	Y	0.65%
		ES026	% Recycled Materials	Percentage	Annual	Y	0.65%
		ES104	Waste Sent to Landfills	Thousand Metric Tonnes	Annual	Y	0.65%
		ES498	Percentage Raw Material from Sustainable Sources	Percentage	Annual	N	0.65%
	Supply Chain		**Supply Chain Disclosure Score**	**Percentage**			**4.79%**
		ES037	Environmental Supply Chain Management	Y/N	Annual	Y	4.79%
	Water		**Water Disclosure Score**	**Percentage**			**4.79%**
		ES247	Water Policy	Y/N	Annual	N	0.28%
		ES081	Total Water Discharged	Thousand Cubic Meters	Annual	Y	1.13%
		ES082	Water per Unit of Production	Liters/Unit of Production	Annual	Y	1.13%
		ES269	Total Water Withdrawal	Thousand Cubic Meters	Annual	N	1.13%
		SA484	Water Consumption	Thousand Cubic Meters	Annual	N	1.13%

Figure 3
PLOT OF ESG/ENV SCORES VS. ARO REVISIONS

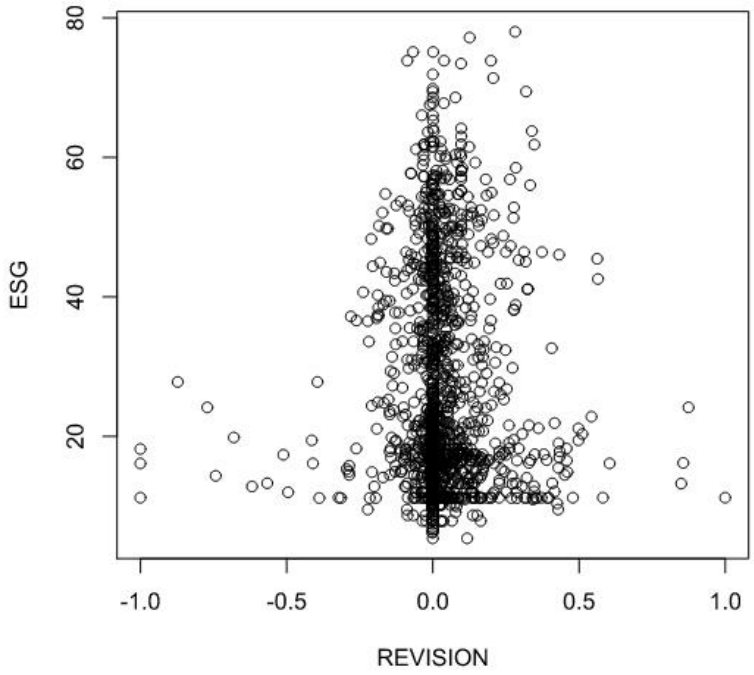

Figure 3a.

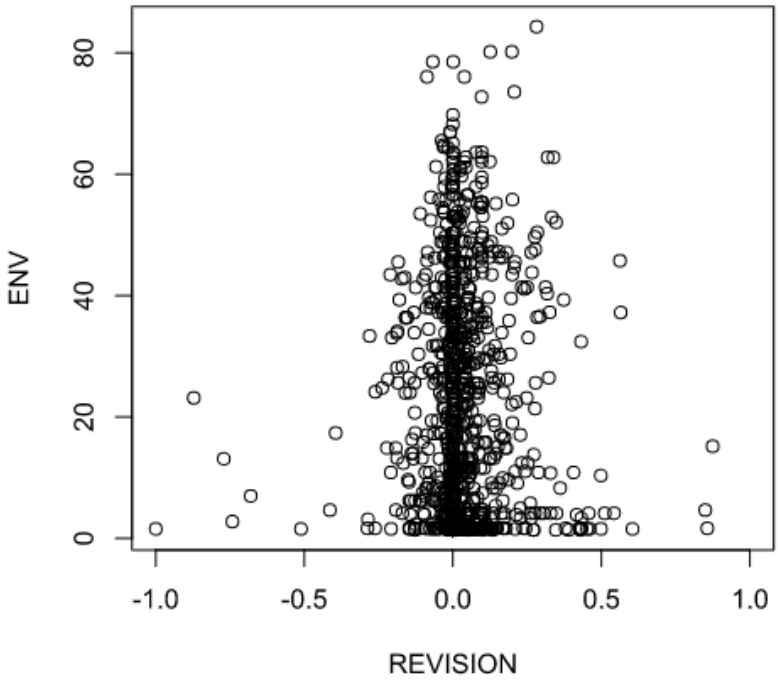

Figure 3b.

This figure plots the magnitude of the ARO revision during the year as a percentage of the ARO ability per the firm's XBRL filing maintained by the SEC on the horizontal axis. The vertical axis reflects the Bloomberg ESG (3a) and ENV (3b) disclosure scores.

Table 1. SAMPLE COMPOSITION

Panel A: Sample Selection

	Firm-years #	Unique firms #
1. Initial sample of firm-years that meet the following criteria: industry code in (101020, 151040, 5510), incorporated in US, year ranges 2012-2019	3447	621
2. Drop observations if any of the variables in the first stage regression is missing	2988	552
3. Drop observations if missing ARO disclosure	2087	400
4. Drop observations if missing Bloomberg ESG disclosure score	1566	286
5. Drop observations if missing ARO Accretion or loss/gain on PPE disposal	1314	253

Panel B: Sample Composition

Industry	Firm-years #	Year	Firm-years #
Oil, Gas & Consumable Fuels (101020)	771	2012	153
Metals & Mining (151040)	140	2013	176
Electric Utilities (551010)	188	2014	183
Gas Utilities (551020)	54	2015	177
Multi-Utilities (551030)	112	2016	169
Water Utilities (551040)	8	2017	168
Independent Power and Renewable Electricity Producers (551050)	41	2018	160
		2019	128

This table presents the sample selection process for the determinants analysis, and for the relationship between ARO recognition and ESG disclosure analysis. The final sample for the determinants analysis consists of 2,988 firm-years from restricted industries, ranging 2012-2019. The final sample for the relationship analysis consists of 1,314 firm-years. We require the existence of both ARO disclosure and Bloomberg ESG disclosure score to enter into the final sample. Panel B reports our sample distribution across Global Industry Classification Standard (GICS) industries, and across years.

Table 2 DESCRIPTIVE STATISTICS

Panel A: Summary Statistics

Statistic	N	Mean	Median	Min	Max	St. Dev.	P(25)	P(75)
ARO_IND	2,988	0.698	1.000	0.000	1.000	0.459	0.000	1.000
ARO_AT	2,087	0.032	0.017	0.000	0.343	0.047	0.005	0.039
ARO_censored	2,988	0.022	0.007	0.000	0.343	0.042	0.000	0.027
SIZE	2,988	7.394	7.660	2.455	11.433	2.233	5.933	9.008
ROA	2,988	-0.038	0.021	-1.000	0.567	0.217	-0.045	0.045
LEVERAGE	2,988	0.351	0.332	0.000	1.000	0.227	0.216	0.457
BTM	2,988	0.490	0.544	-14.068	5.958	1.984	0.321	0.843
PPE	2,988	0.663	0.710	0.000	0.999	0.220	0.555	0.827
AGE	2,988	1.749	1.834	0.000	4.131	0.847	1.242	2.301
FOREIGN	2,988	0.132	0.000	0.000	1.000	0.338	0.000	0.000
HIGHIMPACT	2,988	0.651	1.000	0.000	1.000	0.477	0.000	1.000
FORECAST	2,988	0.626	1.000	0.000	1.000	0.484	0.000	1.000
IO	2,988	38.815	30.053	0.000	100.000	37.757	0.000	75.516
BIG4	2,988	0.667	1.000	0.000	1.000	0.471	0.000	1.000
INNOVATION	2,988	0.090	0.000	0.000	1.000	0.287	0.000	0.000
VISIBLE	2,988	0.063	0.000	0.000	1.000	0.243	0.000	0.000

Panel B: Subsamples With VS. Without ARO

	WITH ARO				WITHOUT ARO					
	N	Mean	Median	St. Dev.	N	Mean	Median	St. Dev.	T-test	Wilcoxon
SIZE	2,087	7.715	7.930	2.241	901	6.651	6.703	2.032	1.064***	1.012***
ROA	2,087	-0.053	0.018	0.221	901	-0.005	0.026	0.204	-0.048***	-0.079***
LEVERAGE	2,087	0.364	0.348	0.216	901	0.321	0.296	0.247	0.043***	0.068***
BTM	2,087	0.461	0.553	2.148	901	0.555	0.511	1.539	-0.094	-0.05***
PPE	2,087	0.712	0.736	0.178	901	0.549	0.593	0.263	0.163***	0.119***
AGE	2,087	1.804	1.866	0.847	901	1.623	1.790	0.836	0.181***	0.014***
FOREIGN	2,087	0.125	0.000	0.331	901	0.148	0.000	0.355	-0.023	0.125
HIGHIMPACT	2,087	0.747	1.000	0.435	901	0.426	0.000	0.495	0.321***	0.747***
FORECAST	2,087	0.690	1.000	0.463	901	0.479	0.000	0.500	0.211***	0.69***
IO	2,087	41.983	41.268	37.844	901	31.476	13.747	36.533	10.507***	28.236***
BIG4	2,087	0.705	1.000	0.456	901	0.578	1.000	0.494	0.127***	-0.295***
INNOVATION	2,087	0.072	0.000	0.258	901	0.133	0.000	0.340	-0.061***	0.072***
VISIBLE	2,087	0.075	0.000	0.263	901	0.036	0.000	0.185	0.039***	0.075***

This table presents the characteristics of all the observations that enter into the determinants analyses final sample. This sample comprises firm-years within selected industries from 2012 to 2019. Panel A presents the summary statistics of all the variables used in the determinants analyses. Panel B compares the characteristics of observations with reported Asset Retirement Obligations (ARO) and the observations without reported ARO. T-test of means and Wilcoxon test of medians are reported. Detailed definition of variables are presented in the Appendix. *, **, and *** represent significance at 10%, 5%, and 1% (two-tailed).

Table 3. DETERMINANTS ANALYSES

	ARO_IND	*ARO_IND*	*ARO_censored*
	(1)	(2)	(3)
SIZE	**0.216*** **	**0.031*** **	-0.001
	(2.80)	**(2.67)**	(-0.59)
ROA	**-1.313** **	**-0.183*** **	**-0.039*** **
	(-2.53)	**(-2.80)**	**(-3.51)**
LEVERAGE	-0.074	-0.021	0.006
	(-0.15)	(-0.28)	(0.51)
BTM	-0.032	-0.005	**-0.002** **
	(-0.75)	(-1.11)	**(-2.17)**
PPE	**2.482*** **	**0.441*** **	**0.021***
	(4.93)	**(4.99)**	**(1.93)**
AGE	0.101	0.016	**0.006***
	(0.83)	(1.00)	**(1.85)**
FOREIGN	-0.019	0.003	**0.013** **
	(-0.06)	(0.05)	**(2.10)**
HIGHIMPACT	**2.245*** **	**0.337*** **	**0.046*** **
	(7.05)	**(6.46)**	**(7.19)**
FORECAST	**0.381***	**0.069** **	0.005
	(1.74)	**(2.02)**	(1.40)
IO	-0.001	-0.000	-0.000
	(-0.26)	(-0.67)	(-1.00)
BIG4	0.300	0.050	0.002
	(1.00)	(1.14)	(0.40)
INNOVATION	-0.093	-0.021	**-0.015** **
	(-0.27)	(-0.33)	**(-2.14)**
VISIBLE	0.115	0.025	**0.020*** **
	(0.30)	(0.51)	**(3.85)**
Constant	-4.052***		-0.045***
	(-7.04)		(-3.80)
Model	Logit	OLS	Tobit
Industry, Year FE	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes
Fitness	0.567 (Pseudo R^2)	0.286 (Adjusted R^2)	904.86*** (Chi^2)
Observations	2,988	2,988	2,988

This table presents the regression results of determinants analyses Column (1) presents the results of a Logit regression, Column (2) presents the results of OLS regression, Column (3) presents the results of Tobit regression. Industry and year fixed effects are applied in the OLS model. Industry and year indicator variables are included in the Logit and Tobit models. Standard errors are clustered at the firm level. Detailed definition of variables are presented in the Appendix. Significance at 10%, 5%, and 1% (two-tailed) are in bold font.

Table 4. DESCRIPTIVE STATISTICS – HYPOTHESIS TESTS SAMPLE

Panel A: Summary Statistics

Statistic	N	Mean	Median	Min	Max	St. Dev.	P(25)	P(75)
ESG	1,314	26.276	19.245	5.372	77.178	15.596	14.108	37.753
ENV	934	21.490	15.862	1.379	80.165	19.102	3.876	35.446
ARO_AT	1,314	0.030	0.018	0.000	0.253	0.036	0.007	0.037
REVISE	1,314	0.032	0.000	-0.392	0.495	0.117	0.000	0.061
REVISE_SQD	1,314	0.017	0.001	0.000	0.384	0.049	0.000	0.009
ACCR_DIFF	1,314	-0.007	-0.003	-0.296	0.211	0.045	-0.018	0.013
PPELOSS	1,314	0.158	0.000	0.000	1.000	0.364	0.000	0.000
ACCR_RATE	1,314	0.059	0.054	0.006	0.256	0.030	0.043	0.070
SIZE	1,314	8.261	8.559	2.532	11.682	2.033	7.221	9.736
LEVERAGE	1,314	0.360	0.339	0.001	1.000	0.187	0.252	0.434
ROA	1,314	-0.021	0.044	-1.000	0.255	0.208	-0.016	0.066
BTM	1,314	0.520	0.572	-18.249	5.967	2.037	0.396	0.853
AGE	1,314	1.918	2.019	0.000	4.131	0.805	1.428	2.358
PPE	1,314	0.733	0.749	0.031	0.988	0.154	0.651	0.852
FOREIGN	1,314	0.150	0.000	0.000	1.000	0.357	0.000	0.000
HIGHIMPACT	1,314	0.826	1.000	0.000	1.000	0.379	1.000	1.000
FORECAST	1,314	0.780	1.000	0.000	1.000	0.414	1.000	1.000
IO	1,314	52.162	63.512	0.000	100.000	36.492	13.747	84.321
BIG4	1,314	0.771	1.000	0.000	1.000	0.421	1.000	1.000
INNOVATION	1,314	0.073	0.000	0.000	1.000	0.260	0.000	0.000
VISIBLE	1,314	0.107	0.000	0.000	1.000	0.309	0.000	0.000

Panel B: Sample Firms VS. Non Sample Firms (same industry)

	SAMPLE FIRMS				NON SAMPLE FIRMS				
	N	Mean	Median	St. Dev.	N	Mean	Median	St. Dev.	T-test
ESG	1,314	26.276	19.245	15.596	583	18.115	14.876	9.856	8.161***
ENV	934	21.490	15.862	19.102	323	10.945	5.517	12.835	10.545***
SIZE	1,314	8.261	8.559	2.033	583	6.948	6.974	2.031	1.313***
LEVERAGE	1,314	0.360	0.339	0.187	583	0.296	0.283	0.232	0.064***
ROA	1,314	-0.021	0.044	0.208	583	-0.007	0.024	0.178	-0.014
BTM	1,314	0.520	0.572	2.037	583	0.622	0.565	1.219	-0.102

Panel C: Revisions of ARO

	= 0	> 0			< 0		
N	390	622			302		
		Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
REVISE		0.106	0.067	0.112	-0.079	-0.04	0.093

This table presents the characteristics of firm-years from previous tables for observations with Bloomberg ESG disclosure scores. Panel A presents the summary statistics of all the variables used in the analyses of the relationship between ARO disclosure and ESG disclosure. The sample comprises firm-years within the selected industries that have both ARO and the ESG disclosure available. Panel B compares the Bloomberg ESG disclosure scores between observations with reported ARO and the observations without reported ARO. Panel C presents the summary statistics of REVISE for sample firm years with 0, >0, and <0 ARO revisions. Detailed definition of variables are presented in the Appendix. *, **, and *** represent significance at 10%, 5%, and 1% (two-tailed).

Table 5. HYPOTHESIS TESTS – ASSOCIATION BETWEEN ARO AND ESG DISCLOSURE QUALITY

Panel A: Correlation Matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
ESG	(1)																				
ENV	(2)	**0.98**																			
ARO_AT	(3)	**0.10**	**0.22**																		
REVISE	(4)	0.00	0.02	-0.05																	
REVISE_SQD	(5)	-0.05	-0.06	-0.04	**0.33**																
ACCR_DIFF	(6)	**0.15**	0.1	**-0.13**	-0.06	0.04															
PPELOSS	(7)	**-0.13**	**-0.12**	**-0.09**	-0.02	0.02	-0.02														
ACCR_RATE	(8)	**-0.15**	**-0.12**	-0.01	**-0.14**	**0.14**	**0.44**	0.07													
SIZE	(9)	**0.70**	**0.65**	**-0.13**	0.03	-0.04	**0.26**	-0.08	**-0.22**												
LEVERAGE	(10)	**-0.12**	**-0.14**	**0.11**	-0.01	-0.01	0.06	0.04	0.08	-0.02											
ROA	(11)	**0.18**	**0.14**	**-0.18**	0.01	-0.04	**0.16**	**-0.11**	**-0.15**	**0.34**	**-0.31**										
BTM	(12)	0.07	0.05	**-0.14**	-0.03	0.01	0.05	0.02	-0.04	0.08	**-0.39**	**0.23**									
AGE	(13)	**0.18**	0.09	**0.24**	-0.07	-0.04	-0.05	**-0.17**	-0.04	0.04	**0.09**	-0.01	**-0.11**								
PPE	(14)	-0.07	**-0.11**	-0.06	**0.09**	-0.01	0.05	0.03	0.06	-0.08	0.07	-0.05	**0.10**	-0.02							
FOREIGN	(15)	**0.25**	**0.27**	0.08	0.02	-0.03	-0.02	-0.02	-0.04	**0.18**	**-0.18**	**0.16**	0.02	0.07	**-0.25**						
HIGHIMPACT	(16)	**0.2**	**0.2**	**0.22**	0.06	0.05	-0.04	-0.03	0.08	-0.02	-0.06	**-0.16**	-0.01	**0.12**	**0.27**	0.04					
FORECAST	(17)	**0.34**	**0.18**	-0.06	0.07	0.01	**0.20**	-0.06	-0.08	**0.55**	0.04	**0.19**	0.06	0.09	-0.04	0.05	0.08				
IO	(18)	**0.35**	**0.18**	-0.01	0.04	-0.02	**0.10**	0.00	**-0.13**	**0.43**	**-0.17**	**0.21**	**0.09**	-0.05	-0.06	**0.16**	**0.11**	**0.36**			
BIG4	(19)	**0.39**	**0.33**	-0.09	-0.03	-0.03	**0.15**	-0.06	**-0.17**	**0.61**	0.05	**0.25**	0.00	0.04	**-0.23**	**0.1**	**-0.14**	**0.40**	**0.31**		
INNOVATION	(20)	0.07	**0.11**	-0.02	-0.04	-0.04	-0.05	0.02	0.00	-0.03	**-0.26**	-0.01	0.04	0.06	**-0.31**	**0.36**	0.01	-0.03	0.05	0.04	
VISIBLE	(21)	**0.41**	**0.36**	0.07	-0.03	-0.07	0.04	-0.05	-0.07	**0.35**	**-0.11**	**0.09**	0.05	**0.11**	**-0.20**	**0.25**	0.08	**0.15**	**0.20**	**0.18**	**0.30**

Panel B: ARO and ESG disclosure

			ESG		
	(1)	(2)	(3)	(4)	(5)
ARO_AT	**47.060*** **	**46.799** **	**46.981** **	**45.705** **	**45.288** **
	(2.58)	**(2.56)**	**(2.56)**	**(2.51)**	**(2.47)**
REVISE		0.533			0.411
		(0.20)			(0.16)
REVISE_SQD		-4.409			-4.333
		(-0.84)			(-0.82)
ACCR_DIFF			-1.014		-1.710
			(-0.10)		(-0.17)
PPELOSS				**-1.638** **	**-1.640** **
				(-2.42)	**(-2.44)**
ACCR_RATE	17.992*	19.257*	18.813	18.750*	21.310
	(1.65)	(1.71)	(1.42)	(1.72)	(1.58)
SIZE	5.007***	5.010***	5.013***	5.000***	5.014***
	(10.88)	(10.88)	(10.72)	(10.89)	(10.74)
LEVERAGE	-8.367***	-8.399***	-8.349***	-8.216***	-8.218***
	(-3.17)	(-3.17)	(-3.14)	(-3.12)	(-3.09)
ROA	-6.221***	-6.219***	-6.189***	-6.491***	-6.435***
	(-3.75)	(-3.75)	(-3.84)	(-3.95)	(-4.03)
BTM	0.106	0.110	0.107	0.115	0.119
	(0.79)	(0.83)	(0.80)	(0.87)	(0.91)
AGE	1.107**	1.108**	1.104**	1.018*	1.012*
	(2.06)	(2.05)	(2.03)	(1.91)	(1.86)
PPE	0.700	0.530	0.701	0.756	0.594
	(0.21)	(0.16)	(0.21)	(0.23)	(0.18)
FOREIGN	5.810***	5.773***	5.813***	5.772***	5.742***
	(2.99)	(2.96)	(2.98)	(2.98)	(2.95)
HIGHIMPACT	6.514***	6.586***	6.518***	6.444***	6.528***
	(3.05)	(3.04)	(3.05)	(3.04)	(3.03)
FORECAST	-2.303**	-2.300**	-2.297**	-2.329**	-2.314**
	(-2.14)	(-2.12)	(-2.14)	(-2.17)	(-2.14)
IO	-0.009	-0.009	-0.009	-0.008	-0.008
	(-0.59)	(-0.61)	(-0.59)	(-0.53)	(-0.54)
BIG4	-0.089	-0.073	-0.090	-0.113	-0.101
	(-0.07)	(-0.05)	(-0.07)	(-0.08)	(-0.07)
INNOVATION	0.436	0.389	0.440	0.511	0.471
	(0.18)	(0.16)	(0.18)	(0.21)	(0.20)
VISIBLE	5.341***	5.309***	5.338***	5.319***	5.283***
	(2.75)	(2.73)	(2.74)	(2.73)	(2.71)
Industry, Year FE	Yes	Yes	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes	Yes	Yes
Observations	1,314	1,314	1,314	1,314	1,314
Adjusted R^2	0.649	0.649	0.649	0.650	0.649

Panel C: ARO and ENV disclosure

	ENV				
	(1)	(2)	(3)	(4)	(5)
ARO_AT	**123.564*** **	**124.284*** **	**123.955*** **	**121.599*** **	**122.833*** **
	(3.99)	**(4.00)**	**(3.98)**	**(3.92)**	**(3.93)**
REVISE		2.375			2.343
		(0.61)			(0.60)
REVISE_SQD		-0.406			-0.149
		(-0.05)			(-0.02)
ACCR_DIFF			4.609		6.13
			(0.23)		(0.30)
PPELOSS				**-1.666**	**-1.689**
				(-1.54)	**(-1.57)**
Controls	Yes	Yes	Yes	Yes	Yes
Industry, Year FE	Yes	Yes	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes	Yes	Yes
Observations	934	934	934	934	934
Adjusted R^2	0.583	0.582	0.583	0.583	0.582

This table presents the univariate and multivariate analyses of the relationship between ARO recognition and ESG and ENV disclosure. Panel A presents the correlation between all the variables used in the regression. Significance at 1% (two-tailed) are in bold font. Panel B presents the regression results of regressing the Bloomberg ESG disclosure score on ARO_AT and other control variables. Panel C presents the regression results of regressing the Bloomberg ENV disclosure score on ARO_AT and other control variables. Industry and year fixed effects are applied. Standard errors are clustered at the firm level. Detailed definition of variables are presented in the Appendix. *, **, and *** represent significance at 10%, 5%, and 1% (two-tailed).

Table 6. CHANGES MODEL

Panel A: Change of ARO and Change of ESG

	Δ*ESG*	Δ*ESG1*	Δ*ARO*	Δ*ARO1*
	(1)	(2)	(3)	(4)
ARO_UP	**0.412****	**0.407***		
	(2.02)	**(1.87)**		
ESG_UP			-0.000	-0.001
			(-0.33)	(-1.18)
Δ*SIZE*	0.647*	0.777**	-0.018***	0.003
	(1.78)	(2.06)	(-3.88)	(1.28)
Δ*PPE*	0.264	-2.802*	0.002	-0.005
	(0.21)	(-1.84)	(0.21)	(-0.46)
Δ*LEVERAGE*	0.884	-2.586***	0.009	0.002
	(0.82)	(-2.63)	(1.11)	(0.36)
Δ*ROA*	0.037	-0.394	-0.012	-0.014***
	(0.07)	(-0.68)	(-1.64)	(-2.90)
Δ*FOREIGN*	-1.395**	0.203	0.001	0.001
	(-2.52)	(0.51)	(0.30)	(0.29)
VISIBLE	0.205	0.326	-0.001	-0.000
	(0.53)	(0.73)	(-0.89)	(-0.37)
Year FE	Yes	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes	Yes
Observations	1,025	1,025	1,025	1,025
Adjusted R^2	0.033	0.019	0.134	0.063

Panel B: Change of ARO and Change of ENV

	Δ*ENV*	Δ*ENV1*	Δ*ARO*	Δ*ARO1*
	(1)	(2)	(3)	(4)
ARO_UP	**0.692***	**0.936****		
	(1.86)	**(2.16)**		
ENV_UP			-0.001	0.000
			(-0.78)	(0.34)
Δ*SIZE*	1.528**	1.764*	-0.023***	0.006**
	(2.06)	(1.91)	(-3.74)	(2.02)
Δ*PPE*	1.285	-3.657	0.003	-0.016
	(0.46)	(-0.95)	(0.21)	(-0.74)
Δ*LEVERAGE*	2.443	-2.784	0.015*	0.023**
	(0.90)	(-0.98)	(1.75)	(2.42)
Δ*ROA*	-0.352	-1.043	-0.004	-0.017**
	(-0.35)	(-0.92)	(-0.75)	(-2.48)
Δ*FOREIGN*	-1.879**	0.601	-0.002	0.002
	(-2.40)	(1.37)	(-1.00)	(1.00)
VISIBLE	-0.297	0.300	-0.001	0.001
	(-0.63)	(0.50)	(-0.74)	(0.54)
Year FE	Yes	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes	Yes
Observations	680	680	680	680
Adjusted R^2	0.009	0.001	0.212	0.119

This table presents regression results of regressing the change of Bloomberg ESG/ENV disclosure score and the change of score in the future on the current change in ARO_AT. Panel A presents the result of the relationship between ARO change and ESG score change. Column (1) and (2) report the result of regressing ARO change on contemporaneous and one-year lead change of ESG score. Column (3) and (4) report the result of reversed regression. Panel B presents the same results for ENV score change. All the control variables included are change variables, except for VISIBLE. Detailed definition of variables are presented in the Appendix. *, **, and *** represent significance at 10%, 5%, and 1% (two-tailed). t-statistics are in parentheses.

Table 7. CROSS-SECTIONAL ANALYSES

Panel A: ESG score as Dependent Variable

	ESG							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Resource		Relevance		Market Attention		Reporting Quality	
ARO	71.799***	9.915	46.435***	3.319	68.309***	32.659*	44.413**	56.994**
	(2.95)	(0.87)	(2.58)	(0.04)	(2.75)	(1.96)	(2.07)	(2.57)
ARO×SIZE	**21.047*** **							
	(3.07)							
ARO×GRI		**113.786****						
		(2.11)						
ARO×CURRENTRATIO			-0.244					
			(-0.78)					
ARO×HIGHIMPACT				43.239				
				(0.56)				
ARO×ANALYST					**39.265*** **			
					(3.39)			
ARO×VISIBLE						**191.969*** **		
						(3.33)		
ARO×AUDITFEE							**25.482****	
							(2.13)	
ARO×DA								**-7.879****
								(-2.31)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,314	1,314	1,314	1,314	1,314	1,314	1,304	1,302
Adjusted R^2	0.659	0.725	0.649	0.649	0.659	0.659	0.661	0.653

Panel B: ENV score as Dependent Variable

	ENV							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Resource		Relevance		Market Attention		Reporting Quality	
ARO	135.989***	59.129**	130.931***	-46.409	148.761***	95.025***	122.807***	134.071***
	(3.77)	(2.57)	(4.08)	(-0.53)	(4.06)	(3.33)	(3.27)	(3.76)
ARO×SIZE	**29.904****							
	(2.33)							
ARO×GRI		108.49						
		(1.40)						
ARO×CURRENTRATIO			**4.527****					
			(2.32)					
ARO×HIGHIMPACT				**177.600***				
				(1.93)				
ARO×ANALYST					**63.417*****			
					(3.29)			
ARO×VISIBLE						**211.964*****		
						(2.76)		
ARO×AUDITFEE							**53.717****	
							(2.04)	
ARO×DA								-8.908
								(-1.16)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	934	934	934	934	934	934	924	931
Adjusted R^2	0.592	0.637	0.588	0.585	0.594	0.592	0.603	0.584

This table presents the cross-sectional analyses results. Panel A presents the result of the cross-sectional variance of the effect of ARO on ESG disclosure score. Panel B presents the result of the cross-sectional variance of the effect of ARO on ENV disclosure score. All continuous variables included in interaction terms are centered by subtracting the mean. Detailed definition of variables are presented in the Appendix. *, **, and *** represent significance at 10%, 5%, and 1% (two-tailed). t-statistics are in parentheses.

Table 8. DiD TEST IN UTILITY

	ESG	ENV	ESG	ENV
	(1)	(2)	(3)	(4)
Treat×*Post*	**2.083*** **	**2.070**	0.254	-1.256
	(3.45)	**(1.59)**	(0.38)	(-0.78)
Treat×*Post*×*ARO_IND*			**2.029*** **	**3.730*** **
			(3.04)	**(3.21)**
ARO_IND			2.595***	2.028
			(2.62)	(0.96)
SIZE	1.336	0.602	0.935	-0.029
	(1.02)	(0.21)	(0.73)	(-0.01)
PPE	5.913	13.159	6.247	14.335
	(1.07)	(1.41)	(1.13)	(1.51)
ROA	-7.023	-11.19	-5.387	-9.119
	(-1.62)	(-1.38)	(-1.30)	(-1.17)
Firm, Year FE	Yes	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes	Yes
Observations	613	494	613	494
Adjusted R^2	0.904	0.865	0.905	0.866

This table presents the Difference-in-Difference result of the ESG/ENV disclosure score change in the subsample of utility industry following the specifications $SCORE = a_i + \gamma_t + \beta_1 Treat \times Post + \beta_2 'CONTROLS + \varepsilon$ and $SCORE = a_i + \gamma_t + \beta_1 Treat \times Post \times ARO\_IND + \beta_2 Treat \times Post + \beta_3 ARO\_IND + \beta_4 'CONTROLS + \varepsilon$. a_i and γ_t refer to the firm and year fixed effect respectively. *Treat* is defined as utility firms that involve electric utility production, *Post* is defined as years after 2015 (including 2015). *ARO_IND* is an indicator variable which equals 1 if a firm report *ARO* liability in the current year. Standard errors are clustered at industry year level to count for other industry shocks that might be correlated. Detailed definition of variables are presented in the Appendix. *, **, and *** represent significance at 10%, 5%, and 1% (two-tailed). t-statistics are in parentheses.

Table 9. INSTRUMENTAL VARIABLE TEST

	First-Stage ARO_AT	Second-Stage ESG
COMMENT	**-0.004*** (-4.10)**	
Predicted ARO_AT		**304.200** (2.55)**
REVISE	-0.012 (-1.52)	4.056 (1.15)
REVISE_SQD	-0.028 (-1.50)	2.677 (0.34)
ACCR_DIFF	-0.069** (-2.27)	16.060 (1.17)
PPE_LOSS_D	-0.007*** (-3.54)	0.182 (0.16)
Controls	Yes	Yes
Industry and Year FE	Yes	Yes
Robust SE	Yes	Yes
Observations	1,314	1,314
Weak IV test (F statistics)	16.83	
Underidentification test (Chi-square p value)	0.006	

This table presents an instrumental variable (IV) analysis. Column (1) presents the regression of ARO_AT on the proposed instrument COMMENT, which reflects the total number of comment letters received by the firm from the SEC over the sample period that are solely focused on ARO issues. All other explanatory variables were used in the previous analysis predicting ESG disclosure score in Table 6, Panel B. Column (2) reports the regression of ESG disclosure score as a function of the predicted value of the IV from the first stage (Predicted ARO_AT) and all of the other controls. Detailed definition of variables are presented in the Appendix. *, **, and *** represent significance at 10%, 5%, and 1% (two-tailed). t-statistics are in parentheses.