Corporate Sustainability: Empirical Evidence of Causality on Financial Performance

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Abstract

The existing empirical literature on the relationship between corporate sustainability performance and corporate financial performance presents inconsistent results. This casts doubt on the direction of this relationship and whether there is such a relationship at all still remains an open question. Literature also presents a gap in addressing the mechanism(s) of the relationship that hinders the convergence of the empirical findings and leaves the question of causality unaddressed. We argue that due to the potential endogeneity problem in the relationship, an empirical strategy without a theoretical base may result in inconclusive or misleading conclusions. We address the potential endogeneity problem in the relationship and identify the possible causes of this endogeneity as: (i) firm level heterogeneity in financial returns, (ii) the relationship between firm's productivity level and the marginal cost of sustainability initiatives, and (iii) measurement error. We implement Instrumental Variable (IV) technique to overcome these biases. Our results present empirical evidence to support the hypothesis that corporate sustainability is positively related (possibly causally) with corporate financial performance. We further find that sustainability initiatives are more costly for more productive companies; thus, they have less incentive to invest. Finally, measurement error in the sustainability metrics does not play a crucial role.

Key Words: Corporate sustainability, Corporate financial performance, IV technique, CSRHUB ratings

1. Introduction

Since the Brundtland Commission's definition of sustainable development in 1987[1], the link between sustainable polices and firms' financial performance remains an open question. Are the firms that implement policies for sustainable development just adding to their costs or despite the costs are they moving towards the triple bottom-line[2]? More specifically, do sustainability initiatives lead to better financial performance? In this context, we define "sustainability initiatives" as processes and practices that are created, modified or revised to mitigate and improve social and environmental consequences (impacts) of businesses.

Sustainability initiatives in terms of sustainable resource use may go hand-in-hand with operational efficiency. Initiatives to improve energy efficiency, reduce carbon emissions in production and transportation, reduce water use, decrease the use of virgin materials, and reuse waste should lead to lower operational costs. There are companies that report such successful outcomes. Coca-Cola, for instance, introduced a monitoring and targeting system in its plants to measure energy and water use, leading to a 15% reduction in water use, with a 6% increase in production.[3] The solar park of Volkswagen AG in North America is expected to supply all the plant's electricity needs when manufacturing lines are not operating.[4] MeadWestvaco Corp. announced the launch of a new family of barrier packaging, which is nestable and 60 percent lighter than comparably sized composite and metal cans. These features led to a decrease in warehousing space and the number of trucks needed for transport.[5]

There are many other similar examples of sustainability initiatives leading to improved financial performance; but is the evidence just anecdotal or is it possible to make a general statement based on empirical analysis? In the literature there are very few academic papers that address this question causally and the results from the studies investigating association are mixed. Some results are not conclusive and some present methodological restrictions. We argue from an economic viewpoint that the impact of sustainability initiatives would reflect on company financial figures (profit, growth, sales, etc.) sooner or later (Stavins et al. 2003)[6]. Measurement issues, modeling errors and endogeneity, however, can hinder the discernment of the relationship immediately.

[1] Report of the World Commision on Environment and Development: Our Common Future published by United Nations in 1987

[2] John Elkington originated the term *triple bottom line*, which introduces environmental, social and economic dimensions of sustainable development into consideration (Elkington, 1998)

[3] "A Bright Idea", Lawrie Holmes, 1 March 2013, Financial Management

[4] "Volkswagen Switches on its Largest Solar-Energy Complex", 30 January 2013, New Zealand Energy & Environment Business Week

[5] "MWV introduces Evertain Barrier Packaging at SNAXPO 2014", 3 March 2014, India Retail News

[6] Economic interpretation of sustainability is allocation of resources over time in a way that provides the highest level of wellbeing in the present and the future of the economic agent.

In this paper, we study the main challenges in estimating causal effect of sustainability on financial performance. In particular, we discuss how the following factors can lead to biased ordinary least squares (OLS) estimates of the relationship: (i) firm level heterogeneity in financial returns, (ii) the relationship between firm's productivity level and the marginal cost of sustainability initiatives, and (iii) measurement error. We identify the magnitude and direction of the estimation bias resulting from each one of the aforementioned sources and investigate how to eliminate them to obtain unbiased estimates. To this end, we use the Instrumental Variable (IV) (Angrist et al. 1996) technique to estimate the causal effect of sustainability on financial returns and compare our results with those from the OLS models to make inferences about the biases. Based on robustness checks on the estimation results, we argue that the marginal costs of sustainability initiatives are higher for more productive firms and as a result the OLS estimation has a downward bias. This is consistent with the strategy and economics literature that productive firms are generally more efficient and less flexible (see for instance Coelli et al. 2005). It is more difficult for such firms to make changes in their processes because of their well-established practices and high efficiencies. They may incur higher costs to implement sustainability initiatives, at least initially, under the assumption that the returns to sustainability initiatives are uniform for every firm. Therefore the relationship between any short-term financial performance measure and sustainability is masked by what we name as an unobserved productivity bias.

Consequently, in this study our contribution is twofold:

- First, we identify and analyze the sources of biases that blur the causal effect of sustainability initiatives on financial performance.
- Second, we empirically show that the IV approach eliminates the impact of inherent productivity bias as well as certain potential measurement errors. Correcting for endogeneity, we show that sustainability performance positively affects financial performance. Furthermore our results suggest that more productive firms have higher marginal costs of sustainability. This result constitutes an important basis for policy-makers in the design of public and private sector policies and to reinforce regulations within the framework of sustainable development.

This paper is organized as follows. Section 2 presents a comprehensive literature review on related areas. In Section 3, the hypotheses are developed. Section 4 lays out the estimation framework and introduces the econometric model. Section 5 describes the dataset and the variables. Section 6 discusses the results and their implications. Section 7 concludes with future research opportunities.

2. Literature Review

Sustainability had long been associated with Corporate Social Responsibility (CSR). It is only during the last decade that more practitioners and academics have acknowledged sustainability as more comprehensive than CSR. CSR activities more often than not, relate to external firm activities that

contribute to societal well-being in an indirect way not through the core business or operations of the firm. Barnett (2007) states "CSR is often described as any discretionary corporate activity intended to further social welfare." Alternatively, sustainable development principles may require firms to change their own business practices and operations in a manner that would eliminate negative social and environmental impact and also instigate positive impact. The literature on CSR goes back several decades. In a detailed literature survey Margolis et al. (2009) have reviewed 251 studies published between 1972 and 2005 and report different and sometimes opposing theoretical perspectives on the mechanisms and the direction of the relationship between CSR and financial performance link.

The literature on the relationship between corporate sustainability and financial performance may be considered relatively new. One can observe a timeline that starts with environmental responsibility/performance and social responsibility/performance as rather separate streams that are lately being integrated under sustainability. We extend the scope of our literature survey also to include relevant studies on the link between corporate social/environmental performance and corporate financial/operational/market performance. Hereafter, we will use "corporate sustainability and financial performance link" to refer to all. In the next section, we focus on the empirical literature that relate to our study the most and review two main research streams that include different sustainability measures and financial performance indicators.

2.1. Empirical Studies

2.1.1 Financial Event Studies. Users of the financial event study methodology focus on the stock market's reaction to the announcements of environmental events. Klassen and McLaughlin (1996) find strong support for the link between environmental performance and market valuation of the firm. On the other hand, Jacobs et al. (2010) and Ortas and Moneva (2011) observe no market reaction to environmental events. Kajander et al. (2012) examine the link between sustainability innovation announcements and market value of large construction sector companies in a number of countries. They find a positive and statistically significant association between sustainability and financial performance. Dam and Petkova (2014) analyze the stock price reaction to announcements of commitment to environmental supply chain sustainability programs of multinational companies and find a marginally significant negative stock price reaction to announcement.

2.1.2 Studies using Sustainability Measures. The second research stream uses multivariate data analysis to examine the association between various performance measures evaluating sustainability, corporate social responsibility or environmental management, and accounting or market value based financial performance. Konar and Cohen (2001), Gonzalez-Benito and Gonzalez-Benito (2005), Brammer et al. (2006), Callan et al (2009), Makni et al. (2009), Aras et al. (2010) and King and Lenox (2002) employ regression analysis to evaluate the link between corporate sustainability and financial performance and obtain mixed results. Konar and Cohen (2001), King and Lenox (2002) and Calan et al. (2009) observe a positive relationship. Gonzalez-Benito and Gonzalez-Benito (2005) and Aras et al.

(2010) assert that there is no link between environmental performance and profitability and no link between sustainability and financial performance, respectively. Makni et al. (2009) observe no significant relationship between sustainability and financial performance, only a unidirectional and negative relationship between the environmental aspect of sustainability and financial performance. Brammer et al. (2006) claim that sustainability is negatively related to stock returns.

Chang and Kuo (2008) try to assert the link between sustainability and financial performance by studying the variation between two groups of firms that are different in terms of their sustainability performances. They find a positive relationship between sustainability and financial performance for the high sustainability firms. Schoenherr and Talluri (2013) divide their samples according to operational performance and observe that financially efficient plants differ significantly from financially inefficient plants in their practice of sustainability initiatives. Their results indicate a positive link.

Since the findings are mixed, one can argue that there are certain factors contaminating the analysis. Some earlier studies address the possible sources of contamination. López et al. (2007) claim that expenses related to sustainability during a certain time period might exceed the incremental revenue generated by sustainability, manifesting as a negative relationship. Montabon et al. (2007) opine that due to the time lag between implementation of environmental management practices and their effect on firm performance, the positive relationship must be stronger than they could document. Wang and Choi (2013) include a time-fixed effect, where they control for effects that may vary over time but are constant across firms, and find that sustainability performance has a positive and significant relationship with corporate financial performance.

Wagner and Bloom (2011) identify the past financial performance as a confounding factor. First they find an insignificant relationship between sustainability and financial performance. They then separate their sample into high- and low-performance firms based on past financial performance. They observe a positive (negative) and significant association between sustainability and financial performance for the financially high- (low-) performing firms. These findings indicate that financially strong firms have more resources to invest in sustainability, which in turn lead to better financial outcomes.

Eccles et al. (2014) divide their sample into high sustainability and low sustainability groups, which are homogeneous in terms of industry, size, growth opportunities, and leverage. They find that high sustainability companies outperform low sustainability companies both in terms of stock market performance and accounting rates of return. They observe no significant association between past profitability and future adoption policies.

Some recent studies attempt to address causality by considering the inherent endogeneity between the variables. A careful consideration of the literature suggests the possible causes of the endogeneity in the relationship as unobserved firm characteristics and firm level heterogeneity in financial returns.

Garcia-Castro et al. (2010) state that companies with characteristics such as good management quality, certain values and culture are more likely to adopt sustainability practices and these unobserved firm characteristics drive the performance. They conduct OLS estimation and find a significant and positive relationship between sustainability and financial performance. They account for endogeneity by fixed-effects and IV estimation and introduce past financial performance into the fixed-effect estimation as a control variable. The effect of sustainability on financial performance is insignificant in the fixed-effect estimation results. Additionally, they employ three sets of instrumental variables; industry characteristics, corporate governance, and visibility. Again the relationship between sustainability and financial performance is insignificant in the IV specifications. They conclude that the inconclusive results from fixed-effects and IV estimation may indicate bias in the OLS estimates and the positive relationship between sustainability and financial performance documented with OLS is actually driven by unobserved firm characteristics. Even though the concern about endogeneity is very valid, the design of the fixed-effects and IV analysis by Garcia-Castro et al. (2010) casts some doubt on their conclusions. Firstly, the OLS specifications in the paper do not include past performance as a control variable. Therefore the results from the OLS and the ones from fixed-effect are not directly comparable in this respect. Secondly, the fixed effects potentially can be attributed to factors that are already related to sustainability. Therefore sustainability initiatives as captured by the sustainability measures in the panel data (especially when the variability in the measure is low over years), can be naturally captured by the fixed effects. This is less of a problem with the IV design.

Surroca et al. (2010) employ a two-stage estimation strategy to determine the relationship between corporate sustainability and financial performance that corrects for endogeneity concerns. They analyze the recursive relationship between sustainability and financial performance and take the mediating role of intangibles such as innovation, human capital, reputation, and culture in both causal directions into account. They claim that sustainability initiatives promote development of intangibles, which lead to improved financial performance. From their empirical findings, they conclude that there is no direct relationship between sustainability (corporate responsibility performance) and financial performance (Tobin's q), but there is a two-way relationship mediated by the intangible resources.

In our literature survey, we focused on the studies that analyze the link between corporate sustainability, environmental management, or corporate social performance and financial performance. Table 1 summarizes the unit of analysis, time frame, sustainability and financial performance indicators, control variables, methods used to evaluate the link between sustainability and financial performance, and the results. For more detailed literature reviews we refer the reader to Lu et al. (2014) and Molina et.al. (2009).

Table 1: Review of studies evaluating the link between sustainability performance and financial performance

Publication	Unit of Analysis	Sample Size	Country	Data Period	Sustainability Measure	Financial Measure	Control Variables	Method	Endogeneity	Findings
Aras et al. (2010)	firm	40	Turkey	2005–2007	Content analysis of corporate reports	accounting based	firm size, risk, innovativeness (R&D intensity)	regression	confounding effect of time lag	inconclusive
Brammer et al.(2006)	firm	451	UK	2002	Ethical Investment Research Service (EIRIS) ratings	market based	firm size, risk, price-to-book value, momentum	regression	Not accounted	negative link
Callan et al (2009)	firm	441	North America	2005	Kinder, Lydenberg, Domini Research & Analytics (KLD) social performance ratings	market based/ accounting based	firm size, risk, R&D intensity, advertising intensity, industry	regression	Not accounted	positive link
Chang and Kuo (2008)	firm	311	Global	2003–2005	Sustainable Asset Management (SAM)	accounting based	firm size, industry	variation between two groups	Not accounted	positive link
Eccles et al. (2014)	firm	675	USA	1993–2009	Thomson Reuters ASSET4	market based/ accounting based	firm size, industry, book-to-market value, momentum	variation between two groups	firm- level heterogeneity in financial returns	positive link
Garcia-Castro et al. (2010)	firm	658	North America	1991–2005	KLD social performance ratings	market based/ accounting based	firm size, industry, risk, R&D intensity	OLS, fix effect and IV estimation	unobserved firm characteristics	poistive link with OLS estimation inconclusive link with fix effect and IV estimation

Publication	Unit of Analysis	Sample Size	Country	Data Period	Sustainability Measure	Financial Measure	Control Variables	Method	Endogeneity	Findings
Gonzalez-Benito and Gonzalez-Benito (2005)	firm	428	Spain	2002	composite measure constructed with survey	operational performance / accounting based	firm size, plant equipment age, industry, use of advanced production and operations management (POM) approaches	regression	Not accounted	inconclusive
King and Lenox (2002)	firm	614	USA	1991–1996	total facility emissions of toxic chemicals	market based/ accounting based	firm size, growth, capital intensity, leverage, R&D intensity, regional wages, regulatory stringency	fixed effect regression	time lag / unobserved firm characteristics	positive link
Konar and Cohen (2001)	firm	321	USA	1989	# of pending environmental law suits, emissions of toxic chemicals	market based	firm size, industry, market share of the firm, industry concentration ratio, sales growth, advertising intensity, R&D intensity, import intensity	regression	Not accounted	positive link
López et al. (2007)	firm	110	Europe	1998–2004	Dow Jones Sustainability Index	accounting based	firm size, industry, risk	variation between two groups	confounding effect of time lag	negative link
Makni et al. (2009)	firm	179	Canada	2004-2005	KLD social performance ratings	market based/ accounting based	firm size, industry, risk	regression	confounding effect of time lag	inconclusive
Montabon et al. (2007)	firm	45	Global		Content analysis of corporate reports	accounting based	no control variables	canonical correlation	confounding effect of time lag	positive link

Publication	Unit of Analysis	Sample Size	Country	Data Period	Sustainability Measure	Financial Measure	Control Variables	Method	Endogeneity	Findings
Schoenherr and Talluri (2013)	firm	402	USA and Europe		composite measure constructed with survey	operational performance	# of product lines, % of sales from largest selling product line, equipment utilization, age of machinery, international ownership, source of input material, emphasis on competitive dimensions	variation between two groups	Not accounted	positive link
Surroca et al. (2010)	firm	599	global	2001–2005	Sustainalytics Platform ratings	market based	innovation, human capital, reputation, culture as mediating variables, physical resources , leverage,liqudity, size, risk, industry, country, year as controls	two-stage estimation, fixed effect estimation	firm- level heterogeneity in financial returns / unobserved firm characteristics	positive link mediated by intangibles related to innovation, human capital, reputation, and culture
Wagner and Blom (2011)	firm	497	Germany and UK	1992 – 2003	composite measure constructed with Survey	market based	firm size, risk, industry, country, ownership	variation between two groups	firm- level heterogeneity in financial returns	Positive (negative) link for financially good(poor) performing firms
Wang and Choi (2013)	firm	622	USA	1995–2000	KLD social performance ratings	market based	consistency in CSP, knowledge intensity as explanatory variables, firm size, debt ratio , industry as controls	fixed effect regression	confounding effect of time lag	positive link

3. Hypothesis Development

Firms with better understanding of the role of sustainability in firm growth and financial performance can make sustainability investments even though the financial returns in the short run do not compensate the cost of investment. Additionally, the decision to invest is easier to take for the financially affluent firms due to their slack resources available for funding new investments. Therefore, looking at the relationship between financial performance and sustainability at any point in time, it is most likely that we have over-representation of the firms with better past performance, and under representation of the firms with lack of common sustainability practices in the industries they operate. If we take such a sample and estimate the role of sustainability on financial performance using OLS, the resulting estimates will be biased and will not reflect the causal effect of sustainability on financial performance. This endogeneity problem inherent in the relationship can be the possible reason for the mixed results in the literature, since depending on the firms used in the study, the relationship can indicate a positive, negative or inconclusive result. However, correcting for the inherent endogeneity in the relationship between financial performance and sustainability using an IV approach, we therefore hypothesize the following:

Hypothesis 1 (H1): The relationship between financial performance and sustainability is positive; an increase in sustainability has a positive causal effect on the financial performance.

3.1 The role of unobserved factors

Although correcting this bias will lead us to an unbiased estimate, it still remains important to tackle the question of what the "reasons" for the endogeneity in the relationship could be. There are various papers in the literature that address this question and come up with explanations (Garcia-Castro et al., 2010, Surroca et al., 2010, Wagner and Blom, 2011, Eccles et al., 2014). We are going to benefit from their conclusions, but our aim in this paper is different. We will take the reasons for endogeneity from a general econometric perspective of unobserved factors, and define them methodologically in terms of factors related to firm performance (and also possible measurement error). In this respect, our approach is more theory (econometrics) driven, and the factors highlighted below can be useful in guiding the applied researcher in interpreting the positive or negative coefficients estimated while studying the financial performance and sustainability relationship.

3.1.1 The role of unobserved productivity. The OLS estimation will produce biased coefficient for the effect of sustainability if there is correlation between a firm's unobserved *productivity level* and the marginal cost of sustainability initiatives. The firm level productivity can be related to various sub-factors such as the technological advancement of the firm, the R&D spending (McWilliams and Siegel, 2000), the number of high skilled employees, the general firm culture for R&D, human capital, etc. If these and similar factors, individually or collectively, are correlated with the level of sustainability initiatives, possibly

through their respective costs, then OLS estimation will be biased if there is no variable controlling for their effects (omitted variable bias). However, one should note that even when these factors are controlled for, OLS estimation might still be biased due to the inherent problem that, in general, we cannot observe some aspect of the firm's productivity (Olley and Pakes, 1996).

Marginal costs of implementing sustainable initiatives can be important in understanding the incentives of profit maximizer firms. If the marginal costs of sustainability initiatives are lower for the firms that are more productive, i.e. those that would earn more at any level of sustainability initiatives than those with lower productivity would then the OLS estimation will be biased upward. If the reverse is true, i.e., the marginal costs of sustainability initiatives are higher for the firms that are more productive then OLS estimation will be biased downward. Out of these two possibilities, it is not clear which one is the actual effect. More productive firms can be cost efficient if sustainability initiatives are already part of the process that makes those firms more productive (as opposed to regulation- enforced applications). In this case, given that the returns to sustainability initiatives are equal, one would expect that productive firms invest more in sustainability. However, it may also be argued that the marginal costs of sustainability initiatives are higher for more productive firms. Because of the already-established business practices and efficient production processes, it can be harder for more productive firms to change the way they operate. In this case, those firms are likely to incur higher costs to implement sustainability and have less incentive to invest in sustainability compared to less productive firms. We believe this is an open question and needs to be explored not only empirically as this paper does but also theoretically. Therefore, to cast a conclusion on the effect of unobserved productivity on the estimated OLS coefficient, we need to bring the issue to the data. With the proper identification (like IV as we discuss) that controls for the endogeneity, the direction of the bias will help us to disentangle the role of unobserved productivity in the sustainability financial performance relationship. We hypothesize the following:

Hypothesis 2 (H2): If the IV estimation produces a larger coefficient estimate than the OLS estimation of the effect of sustainability, the marginal costs of sustainability initiatives are higher for the firms that are more productive.

As will be discussed below, unobserved productivity is not the only factor that can create endogeneity. What we call comparative advantage bias can also lead to a biased estimate in the OLS estimation. Therefore, for instance if the IV estimation produce a lower coefficient estimate than the OLS estimation of the effect of sustainability, this potentially can be due to both unobserved productivity (for which we don't know the direction of the bias theoretically) and/or the comparative advantage (for which we know that there is an upward bias). In this case we cannot separately identify the source of the bias from data, nor can reject or accept whether productivity produces an upward or a downward bias.

3.1.2 Firm-Level Heterogeneity: Comparative Advantage. All else being equal, firms with higher financial returns to sustainability, have the incentive to undertake more sustainability initiatives. In this case, assuming no productivity bias, cross-sectional estimates are likely to yield upward biases on the average marginal return to sustainability. This *comparative advantage* bias arises from the fact that the differences in the sustainability-financial performance relationship result from the differences in returns as opposed to the differences in the preferences for sustainability, costs of implementing sustainability initiatives, or productivity. Especially for firms with higher levels of returns to sustainability, this can generate higher investments in sustainability initiatives. This occurrence can also be seen empirically as a reverse causality problem.

To sum up, we argue that OLS estimates are upward biased if a firm's return to sustainability initiatives is positively correlated with the amount of sustainability initiatives undertaken by the firm. The closest empirical evidence for return heterogeneity in this setting is addressed in Eccles et al (2014). In their study, the effect of corporate sustainability is estimated separately for high sustainability and low sustainability companies. Findings show that high sustainability companies significantly outperform their counterparts over the long run. From our discussion's viewpoint their finding can be interpreted as follows: if one were to estimate the effect of sustainability on financial performance by OLS using all the firms (high and low sustainability) in their data set then the effect of sustainability on financial performance would be biased upwards. The logic behind this is simple. When one pulls all data together, the significant association between financial performance and sustainability for the high sustainability firms will over-represent the effect of sustainability for an average firm since the low sustainability firms do not perform well financially. This sort of endogeneity is important to be addressed since it will always lead to an over estimation of the OLS coefficient. However, there is also unobserved productivity as a potential source of endogeneity. Therefore if there is a positive unobserved productivity bias on top of this, then the upward bias in OLS is even larger. If there is a negative productivity bias, then the direction of the overall bias in OLS estimates is ambiguous. Assuming the productivity bias is a downward bias, if the comparative advantage bias dominates, then we expect to see an upward bias, which would result in a larger coefficient estimate for the effect of sustainability in the OLS estimation. Therefore, we hypothesize the following:

Hypothesis 3 (H3): If the IV estimate produces a larger coefficient compared to OLS estimate, the productivity bias dominates comparative advantage bias.

3.1.3 The role of other unobserved factors. Sustainability initiatives are generally approximated by some index measures at the firm level. However, apart from the fact that the index itself may not be a perfect measure, it can be mis-measured or mis-reported. Empirically, the researcher can only observe

information on indices like CSRHUB[7], GRI[8], Dow Jones SI[9], etc., rather than the actual investments, projects, and initiatives on sustainability. This brings forth the possibility of measurement error. Econometrically, measurement error is a form of attenuation bias in the OLS setting. Assuming that the return to sustainability is positive[10] then the attenuation bias is downward. Therefore, the coefficient of sustainability will be lower whenever measurement error is a concern in the estimation of the relationship between sustainability and financial returns[11].

Theoretically the direction of the overall bias in the OLS estimates is ambiguous. Unobserved productivity and comparative advantage both lead to an upward bias if the productivity bias is positive. In this case, the overall effect will be a combination of the upward biases from these two sources and the downward bias due to the measurement error. As mentioned when discussing the productivity bias, there is no clear evidence (yet) showing its direction. If the productivity bias is negative then the productivity bias and measurement error will work as downward, whereas the comparative advantage bias will work upward. The overall effect again will be ambiguous. In our econometric formulation, we benefited from the sub-category measures to rule out the effect of measurement error. Theoretically measurement error can cause a downward bias in the estimated coefficient. However, we hypothesize that:

Hypothesis 4(H4): Measurement error in the sustainability metrics does not play a crucial role in causing a bias in the estimation.

4. The Estimation Framework

We develop an econometric model to understand the factors that hinder measurement of the causal effect of sustainability on financial returns. Our model is a general linear model with financial performance as the dependent variable and sustainability along with a set of controls are the explanatory variables. The coefficient of interest in this specification is the coefficient of the corporate sustainability. This model is first estimated with OLS and then with a two-stage least squares approach using sustainability news rates as an IV for -sustainability initiatives. Only with the second method, we control for the endogeneity in the relationship. Comparing with the potentially biased OLS estimates, we highlight possible mechanisms through which endogeneity works and discuss how IV estimation corrects for this bias.

[7] http://www.csrhub.com

[8] https://www.globalreporting.org

[9] http://www.djindexes.com/sustainability/

[10] This is our founding assumption as opposed to the existing empirical literature. In this literature (Garcia-Castro et al., 2010), the effect of sustainability is treated as unknown and the empirical strategy relies on to identify both the sign and the magnitude of the coefficient of sustainability (in an OLS, IV setting with cross-sectional observations, or using a fixed-effects estimator whenever panel data is available)

[11] The literature on the relationship between financial returns and sustainability is at its infancy and to our knowledge measurement error has not been a specific concern in any previous study.

4.1. The Econometric Model

In this section, we aim to explain the main econometric challenges (such as endogeneity and attenuation bias[12]) in estimating the financial returns to sustainability and provide a framework to estimate the causal effect of sustainability on financial performance. Suppose that financial returns, FR (ROA, ROE etc.) are linear in sustainability initiatives (SUS) as in equation (1) and there is no firm-level heterogeneity[13] in returns. In this equation, β measures the return (causal) due to sustainability initiatives.

$$FR = \alpha + \beta SUS + \delta X + \epsilon \qquad (1)$$

Obviously, there will be many other variables that affect firm financial performance and some of them are likely to be related with sustainability as well. Therefore, in empirical applications, a selected set of variables (X)[14] are used in order to control for the omitted variables, which otherwise makes the OLS estimate of β biased. In this respect ϵ is what remains after including all relevant observable variables.

4.2. Correcting for Endogeneity Bias

Assuming that there is no measurement error, the IV method can be used as an alternative to the OLS estimation of the return to sustainability in order to overcome the endogeneity bias. If there is also measurement error, IV is still an alternative to correct for the biases due to endogeneity and measurement error. In the absence of heterogeneity in financial returns, if there is an observable instrument, z, that affects sustainability initiatives in a firm but is uncorrelated with the unobserved productivity, then an IV estimator based on this instrument will yield a consistent estimate of the average financial returns to sustainability[15]. Equation (2) describes the first condition for an IV that the coefficient γ_1 in the equation should be significant to have a relevant instrument[16]. Furthermore, to have a valid IV we need the condition in equation (3) to be true.

$$SUS = \gamma_0 + \gamma_1 z + \vartheta \qquad (2)$$

$$cov(z, \epsilon) = 0 \qquad (3)$$

When financial returns are the same for every firm (no heterogeneity), then any valid instrument will identify the same parameter value β in equation (1), the causal effect of sustainability on financial returns.

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[12] Endogeneity and attenuation bias are well-defined concepts in the econometrics literature. We refer the interested reader to the methods in the econometrics literature for addressing similar problems (see for instance Wooldridge, 2010).

[13] Firm- level heterogeneity can result in different returns to sustainability for different firms and firms with higher levels of returns to sustainability have the incentive to invest more in sustainability, all else equal. This will be elaborated more in the rest of the section.

[14] X is a column vector of variables that affect the firm financial performance and δ is a row vector of parameters.

[15] Consistent means that the difference between the probability limit of the estimator and the true parameter in the population is equal to zero.

[16] Of course when we have other control variables in the main regression beside the sustainability variable, the coefficient γ_1 should be significant given the other variables. In other words, equation (2) should include all the control variables along with the instrument.

If there is heterogeneity a stronger independence assumption between the instrument, firm-level productivity, and the error in the financial return equation is needed to produce a consistent estimate. However, the stronger independence assumption is likely to be violated by any instrument. In this case, different instruments measure different effects depending on, which firms are induced to change their optimal sustainability choice (reflected through their sustainability scores) by a change in the instrument. For instance, Imbens and Angrist (1994) formalize the notion that when there is heterogeneity in returns, IV actually measures a Local Average Treatment Effect (LATE). The LATE parameter is consistently estimated given that the instrument satisfies the standard assumptions, but it consistently estimates the financial return to sustainability only for a selected subset of the population of firms — those, that are affected in their decisions on the level of sustainability by a change in the instrument.

In our model, we don't need to make any prior assumptions about the direction of the bias. As discussed above, the bias can potentially be an upward or a downward bias in the OLS estimation. The relative importance of the different sources of endogeneity combined with the possible measurement error will determine the direction and magnitude of the bias. The focus of the analysis here is to carefully identify the magnitudes and directions of the biases resulting from unobserved productivity, heterogeneity, and possibly measurement error. The ultimate goal is to estimate the causal effect of sustainability on financial returns using the IV estimation framework and to compare the results with the OLS methodology to make inferences about the size and the direction of the biases.

5. Data and Variables

5.1. Data

We collected annual company data on corporate sustainability and corporate financial performance for years 2010–2013. We used the CSRHUB database to construct company sustainability scores. CSRHUB database provides comprehensive coverage of CSR ratings both in terms of the number of companies and the scope of the sustainability measures. For company financial information we used COMPUSTAT and focused on the North American subset. In this subset, there are 8,523 companies with revenues larger than 50 million USD out of which 2,263 companies match those in the CSRHUB database. We extracted total assets, total stockholders' equity, revenue, net income and market value for fiscal years 2010–2013 from COMPUSTAT. We obtained the total number of news items and the number of sustainability related news items for each company in the date range 01/01/2012–1/12/2012 from the Factiva database[17]. We used "sustainability and sustainable" as keywords for the latter. We eliminated 25 of 2,663 companies in our COMPUSTAT-CSRHUB matched sample that are not present in the Factiva database.

[17] http://www.dowjones.com/products/product-factiva/

5.2. Variables

We used CSRHUB's sustainability ratings as our sustainability measure. CSRHUB considers the ratings and opinions from more than 350 different sources such as (i) Socially Responsible Investing (SRI) - also known as Environment, Social, Governance (ESG) analysis firms; (ii) Non-Governmental Organizations (NGOs) such as foundations, associations, union groups, and activist groups; and (iii) government databases, publications and research reports. All available data on a company from multiple sources are grouped under four categories; community, employees, environment, and governance. The data are then weighted and combined to produce an aggregate score. The aggregate scores are transformed into a rating on a 0 to 100 scale. CSRHUB's approach of collecting data from third parties and not relying on the company's self-reporting is more assuring (than its alternatives) in terms of objectivity. Furthermore companies are not included in the database upon their own request. [18]

In the literature, financial performance has been operationalized by market based as well as accounting based measures. Accounting based measures include return on assets (ROA) return on equity (ROE), return on sales (ROS), profit before taxation, and cash flow. Tobin's q ratio, market returns, and earnings per share capture the firms' market value. We use ROA and ROE to measure financial performance as these are among the most-commonly used measures in the literature. Moreover, they reflect the long-term performance of the company. We calculate ROA as net income divided by total assets and ROE as net income divided by total stockholders' equity.

Since firm size is expected to have an influence on sustainability and financial performance, we include company size in the model as a control variable. To be able to compare companies in labor intensive versus capital/technology intensive industries, we control for the number of employees and the annual revenue in millions of dollars. We also include firm age in our analysis, since it may have an effect on financial returns. Since COMPUSTAT provides Standard Industrial Classification (SIC) code information on the primary line of business for each firm, we operationalize the industry by using the one-digit SIC codes.[19]

5.3. Instrumental Variable

Our instrumental variables are the ratio of the number of sustainability related news items to the number of all news items for a company over a year (inst1) and the ratio of the number of sustainable operations related news items to the number of all news items for a company over a year (inst2). We obtained the data from

[18] http://www.csrhub.com/content/csrhub-ratings-methodology/

[19] We also controlled for industries and sub-industries for companies as they are classified in the CSR database. There are no significant changes compared to the case where industry is controlled by one-digit SIC codes. The unreported results can be provided upon request.

Factiva with keyword search. For inst1 we included the words "sustainability" and "sustainable". For inst2 we narrowed down the search by adding keywords that only relate to sustainable operations[20].

In econometric analysis, when the IV technique is used, the validity of the instrument is always a concern. Two important characteristics of an IV are that it predicts the endogenous variable reasonably and it is not correlated with the error term in the model. We claim that companies with higher ratios undertake more initiatives regarding sustainability and attain better sustainability performances. Furthermore, this ratio does not directly affect their ROA or ROE, but its effect is through the sustainability initiatives of the firm.

5.3.1. IV Relevance. In the keyword search we encountered news items that can be grouped under the following categories.

1. New sustainable product launches
2. New process implementations
3. Measuring sustainability
4. Recognitions and awards on sustainability
5. Sustainable sourcing
6. Sustainable facilities
7. Strategic alliance and research partnerships
8. Sustainability related news, where the companies' actions are jeopardizing the environment and/or society

We did not distinguish between news items with respect to their positive or negative relevance to sustainability. One might argue that, for a particular company, a high number of news items falling in category eight would violate the monotonicity assumption[21]. However, if the news contents are not systematically different for some firms or industries, then our IV will still be valid, though it will experience some efficiency loss. We are able to show in Table 4 that news ratio and CSRHUB ratings have a positive linear relationship so in general monotonicity prevails.

5.3.2. IV Validity. Two firms with different sizes and operations are expected to take varying levels of media attention. The news ratio specifies the percentage of sustainability initiatives within all activities of the firm that take media attention. The firm level variability in the news ratio should indicate the level of sustainability initiatives undertaken by the firms, but it is not expected to affect the financial returns other than through this channel. This is mainly because, the ratio is more stable compared to the total number of

[20] Keywords: (sustainability or sustainable) and ((operations or process) or (efficiency or productivity) or((employee or work force) and (health or safety or lay off or part time flexible or training) and (policy or relations or standards)) or ((reduce or reduction or management or manage or reuse) and (waste or material or energy or water or recycle or land use or landfill)))

[21] Monotonicity is required for the identification of the causal effect. For instance, the relationship between the IV (ratio of sustainability news items to total news items) and the sustainability initiatives is expected to be positive, and therefore a higher ratio should be associated with a larger investment on average.

news items related to sustainability, which can be directly affected by the increase in investments in sustainability initiatives. Our keyword search as indicated captures the words "sustainability" and "sustainable" in the total news items. It is natural to expect externalities related to sustainability initiatives that present themselves in other related news items not being captured by these keywords. All these remarks indicate that the ratio of sustainable news items to the total news items of the company can potentially serve as a proper IV for our purposes.

When only one instrument is used, it is not econometrically possible to test instrument validity. We address this issue partially by adding another instrument and running an over-identifying test. The second IV is constructed by narrowing our search on Factiva to news items that only relate to sustainable operations. In our robustness checks (see Section 6.2), we test the claim that media attention does not affect ROA or ROE other than its indirect effect using this second instrument. Results favor instrument validity.

Another concern regarding the validity of our IV may arise from the evidence presented by the event study research stream, which suggest media attention regarding environmental performance or sustainability initiatives does have a direct impact on stock price, which influences equity, which will in turn influence Tobin's q. Klassen and McLaughlin (1996) and Jacobs et al. (2010) study environmental events such as the announcement of an environmental award or environmental crises or penalties. Hamilton (1995) studies the stock market's reaction to the disclosure of toxics release inventory data. Even though we use media attention as an indicator of sustainability performance similar to the aforementioned studies, the resemblance ends there. In the event study methodology, only the effect of a single event on the stock price is used to measure the relationship between sustainability and financial performance. As explained above, we take the ratio of sustainability related news items to all news items over a year as our sustainability indicator and measure its interaction with ROA, which is an internal accounting measure and independent of the stock market's reaction in the short run. Moreover, we control for market value, so that the media attention and market reaction link established by the event study research does not confound the effect of sustainability on financial performance.

6. Results and Discussion

Table 2 displays the summary statistics for financial return (ROA and ROE), sustainability (CSRHUB overall score and sub categories), controls (age, firm size captured by the number of employees and total assets, market value) and two sets of IV. The average ROA has decreased steadily from 0.0494% in 2010 to 0.0317% in 2013. The average ROE has fluctuated over the years. Moreover, looking at the standard deviations and minimum and maximum values we can infer that ROE is more volatile than ROA. The average overall CSRHUB score and average sub category scores are more or less at the same level. The average ratio of the number of sustainability related news items to the total number of news items in 2012

is 2.42 %, while the average ratio of the number of sustainable operations related news items to the total number of news items in 2012 is 1.75 %.

Table 2: Summary Statistics

Variable Name	Explanation	# of Observations	Mean	Standard Deviation	Min	Max
roa2013	ROA in 2013	1668	0.0317	0.0835	-0.5609	0.1984
roa2012	ROA in 2012	1668	0.0330	0.1141	-1.7026	0.3606
roa2011	ROA in 2011	1668	0.0485	0.0943	-0.6302	0.8797
roa2010	ROA in 2010	1660	0.0494	0.0984	-1.2055	1.3661
roe2013	ROE in 2013	1680	0.0840	0.2283	-1.1192	1.1832
roe2012	ROE in 2012	1680	0.1586	2.4341	-21	70.3846
roe2011	ROE in 2011	1679	0.0996	2.465	-78.3182	37.5153
roe2010	ROE in 2010	1672	0.0509	2.0391	-57.9196	19.2598
overall_csr	CSRHUB overall score	1668	53.5366	6.6294	31	74
community_csr	CSRHUB community score	1683	52.4860	8.6070	27	83
governance_csr	CSRHUB governance score	1682	51.5779	9.8157	9	83
employees_csr	CSRHUB employee score	1682	55.7271	8.2128	0	80
environment_csr	CSRHUB environment score	1683	54.3155	9.5427	27	88
Age	natural logarithm of the firm age	1667	2.7069	0.832	0	4.1897
lnemply13	natural logarithm of the number of employees in 2013	1659	2.0698	1.3497	0	6.3523
lnasset12	natural logarithm of the assets in 2012	1668	7.8458	1.6782	3.3553	13.4377
lnmv12	natural logarithm of the market value of the firm in 2012	1501	7.5395	1.558	1.0406	13.348
inst1	ratio of the number of sustainability related news items to the total number of news items in 2012	1655	0.0242	0.0319	0	0.3333
inst2	ratio of the number of sustainable operations related news items to the total number of news items in 2012	1653	0.0175	0.0251	0	0.3021

6.1. IV Models: Evidence for Causality

In all the estimations in Table 3, the CSRHUB overall score (overall_csr) is used as the measure of the sustainability level of a company. Based on our discussion about the econometric obstacles to estimate the causal relationship in the OLS estimation, we estimate the relationship between the CSRHUB score of a firm and the ROA using an IV framework and contrast it to the OLS results to shed light on the size and direction of the bias.

Table 3: OLS and IV Regressions of Financial Performance (ROA) on CSRHUB score (CSR overall score)

Dependent variable: roa2013								
	OLS (1)	IV (1)	OLS (2)	IV (2)	OLS (3)	IV (3)	OLS (4)	IV (4)
overall_csr	0.00115***	0.00222	0.000700**	0.00334***	0.00044	0.00289**	0.000499	0.00406**
	(0.000347)	(0.00146)	(0.000283)	(0.00126)	(0.000288)	(0.00144)	(0.000316)	(0.00167)
Age			0.00263	0.0027	0.00156	0.00212	0.00141	0.00194
			(0.00172)	(0.00181)	(0.00169)	(0.00181)	(0.00175)	(0.00194)
roa2012			0.202***	0.197***	0.196***	0.194***	0.140**	0.139**
			(0.0634)	(0.0623)	(0.0633)	(0.0629)	(0.0569)	(0.0566)
roa2011			0.262***	0.256***	0.257***	0.253***	0.157***	0.150***
			(0.0503)	(0.0505)	(0.0499)	(0.0504)	(0.0498)	(0.0494)
roa2010							0.117***	0.119***
							(0.0419)	(0.0435)
lnemply13					0.00629***	0.00361*	0.00766***	0.00422
					(0.00128)	(0.00195)	(0.00196)	(0.00274)
lnasset12							-0.0209***	-0.0197***
							(0.00374)	(0.00406)
lnmv12							0.0247***	0.0234***
							(0.00371)	(0.00399)
Industry Dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.03	-0.0872	-0.0534***	-0.192***	-0.0457***	-0.172**	-0.0705***	-0.253***
	(0.0190)	(0.0785)	(0.0163)	(0.0681)	(0.0163)	(0.0760)	(0.0234)	(0.0910)
R-squared	0.008	0.002	0.277	0.234	0.286	0.251	0.34	0.273
Observations	1,668	1,655	1,667	1,654	1,658	1,645	1491	1481

Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

In column OLS(1), the OLS regression of ROA on the sustainability measure is presented without any control variables. The coefficient of the variable "overall_csr" is positive and significant. A one-point increase in the sustainability index increases ROA by 0.11%. The result in the column IV(1) is the IV estimation where we use the ratio of sustainability related news items in the total news items about a firm as an instrument for the sustainability index. The estimated coefficient suggests that one-point increase in the sustainability index increases ROA by 0.22%. Although the coefficient is not significant at the conventional levels of significance but only at 15%, it presents an evidence for a negative bias in the OLS estimate of the relationship. In columns OLS(2) and IV(2), the relationship is estimated by OLS and IV respectively using the set of controls; ROA in 2012 (roa2012), ROA in 2011 (roa2011), the age of the firm (Age), and the industry indicators. In columns OLS(3) and IV(3), the natural logarithm of the number of employees in year 2013 (lnemply13) is added as an additional control for the firm size. Additionally in columns OLS(4) and IV(4), ROA value in 2010 (roa2010), log of assets in 2012 (lnasset12), and the log of market value of the firm in 2012 (lnmv12) are added as controls.

The coefficients from the OLS(2) and OLS(3) estimations show the effect of a one-point increase in the sustainability index on ROA as 0.070% and 0.044% respectively. As expected the effect decreased by the addition of the controls (from the 0.11% estimated in OLS(1)). The effect further decreases with the additional controls used in OLS(4). Also the coefficient, although being positive loses its significance after the specification OLS(2). However, when we look at the estimates from the IV specifications, we see that the respective coefficients for the effect of CSRHUB score are 0.33%, 0.29%, and 0.40% respectively for IV(2), IV(3) and IV(4), and are statistically significant at the 5% level. The significant coefficients in IV but not in OLS estimates in Table 3 yield support for Hypothesis 1. The inconclusive result that we obtain from the OLS estimation turns to a significant result once the endogeneity in the sustainability financial performance relationship is controlled. Therefore, given the positive sign of the IV coefficient, we conclude that sustainability in fact affects financial performance positively.

In terms of the direction of the bias, estimation results also suggest that the OLS estimates are biased downwards and underestimate the true relationship between financial returns and sustainability. Particularly taking the OLS (4) and IV (4) estimates with the most set of controls, the estimated coefficients of 0.000499 (OLS) and 0.004060 (IV) indicate an 8-fold difference in the estimated effect of CSR on financial returns. Hypothesis 2 states that if the marginal costs of sustainability initiatives are higher for the firms that are more productive then the IV estimation should reduce the downward bias, hence increase the coefficient estimate. A 8-fold increase in the estimated coefficient is consistent with the explanation that actually it is more costly for the productive firms to make sustainability investments. This result is extremely important and we discuss it further below.

In discussing the econometric challenges in the casual estimation, we stated that the comparative advantage (heterogeneity) effect leads to an increase in the coefficient of the OLS estimate, while the unobserved productivity may lead to a negative or positive bias depending on the cost. The IV estimation results in Table 3 conclude that OLS estimation is biased downward. Therefore, in terms of testing Hypothesis 3, the lower OLS coefficient is not consistent with the dominating effect of comparative advantage bias. Since theoretically we have no doubt in predicting the effect of comparative advantage bias which is positive, we conclude that productivity bias turns out to be the dominating factor in creating the endogeneity in the estimation.

The productivity bias seems to dominate the positive bias that could be caused by the heterogeneous returns. This result is striking in the sense that the insignificant or negative results in the literature for the effect of sustainability on financial performance can be a result of this particular endogeneity not taken into account properly. Empirical evidence supporting our finding comes from Schoenherr and Talluri (2013). In their paper, authors examine the environmental sustainability initiatives among which they call efficient and inefficient plants. They show that, in the U.S., efficient plants adopt the ISO 14000 certification[22] less than their inefficient counterparts. This can be interpreted as efficient plants being less proactive in their practice of environmental sustainability. Generalizing this finding to all firm level sustainability initiatives, one explanation comes as: efficient firms are less proactive since the cost of sustainability initiatives is higher for them. From an economic point of view, those firms, unless regulation binds them, will choose the efficient level of sustainability initiatives where the marginal cost of investing more is equal to the benefit. This level can be lower albeit economically efficient. Furthermore in an OLS context, this does not contradict with the positive benefits from sustainable initiatives. It only means that if the unobserved productivity (or efficiency) of the firm is not taken into account, the OLS estimation will average the potentially more proactive less efficient firms with the less proactive efficient firms. The result will show itself as a negative bias in the estimation.

6.2. IV Relevance and Validity Tests

6.2.1. Relevance. A possible concern about the IV estimation is how well the instrument performs in explaining the variation in CSRHUB score when all set of controls are used in the regression specification.

[22] ISO 14000 is a series of environmental management systems standards, which uses the same approach as its predecessor ISO9000 quality standarts. Requirements for ISO 14000 certification include having procedures to identify all environmental aspects of the site's operations, to ensure safe handling and disposal of hazardous materials, to communicate with interested parties, and to have a procedure that will ensure that the company is aware of and complies with all relevant legislation(Corbet and Kirsch 2001, Montabon et al. 2000).

The relevance of our instrument can be checked using a first stage estimation of overall_csr on the instrument and all the other covariates used in the respective equations. Lack of explanatory power of the instrument would make all the analysis redundant since the IV estimation depends crucially on the relevance as well as the validity of the instrument. Table 4 below reports the results from the first stage estimation of CSRHUB score on the set of controls and the instrumental variable. The specifications FS(1) to FS(4) in the table directly correspond to the IV estimations IV(1) to IV(4) in Table 3. As shown in Table 4, the instrument performs well and is always significant even when all the controls are added in FS(4).

6.2.2. Validity. As discussed in Section 5.3.2, another concern in IV estimation would be the instrument validity. Since we use only one instrument for the sustainability index, it is not possible to test instrument validity to assert that the instrument is uncorrelated with the error term in the estimated equations. To address this issue we added another instrument and ran an over-identifying test to check the robustness of our findings. The second instrument we use is the ratio of the number of sustainable operations related news items to the overall number of news items of the company on the Factiva database. With two instruments we can test the validity of the assumption of no correlation between the error term and the instruments used to a certain extent. Using the specification in IV(4), we run a J-test [23]after replicating the estimation by adding the second instrument in the first stage. In the full relevance, we expect any instrument used to produce the same parameter estimates from the IV regression and J-test relies on this assumption to test the relevance. The null hypothesis states no correlation between the instruments and the error term. The test of over identifying restrictions on IV(4) with two instruments has produced a test score of 3.20039 (p = 0.0736). Therefore, we cannot reject the null at 99% or 95% confidence levels, suggesting the instruments used are exogenous to some extent.

6.3. Robustness Checks

As discussed in Section 3.1.3., measurement error is another source of potential downward bias in OLS estimation. If there is any measurement error, the IV technique will correct it and the increase in the coefficient of sustainability can be attributed to the productivity bias or the measurement error, or both. We believe that the downward effect we observe is mostly from the productivity bias and to strengthen our claim, we carried out additional regressions, controlling for the measurement error to a certain extent.

[23] When we have more instruments than we need to identify equation (2), we can test whether the additional instruments are valid. We rely on a simple regression-based procedure: We estimate equation (2) with two sets of IV and obtain the residuals. We regress ϑ on all exogenous variables including a constant. Under the null that $E(z\vartheta) = 0$ and homoscedasticity assumption, $NR_{\vartheta}^2 \sim x_q^2$, where q=1, since we have one over identifying restriction. If we fail to reject the null, then we can have some confidence in the overall set of instruments used(Wooldridge 2010).

Table 4: First Stage Estimation for the IV (Regressions of CSRHUB score on the instrument (ratio of sustainability news items on total news items))

Dependent variable: overall_csr				
	FS (1)	**FS (2)**	**FS (3)**	**FS (4)**
inst1	35.91***	35.80***	31.23***	28.26***
	(5.017)	(5.163)	(4.649)	(4.548)
Age		-0.0108	-0.194	-0.123
		(0.194)	(0.189)	(0.194)
roa2012		2.149	0.739	0.252
		(1.427)	(1.384)	(1.463)
roa2011		2.599	1.981	2.236
		(1.873)	(1.825)	(2.266)
roa2010				-0.782
				(2.208)
lnemply13				0.903***
				(0.194)
lnasset12				-0.416
				(0.273)
lnmv12			1.002***	0.409
			(0.126)	(0.251)
Industry Dummies	No	Yes	Yes	Yes
Constant	52.67***	51.33***	50.59***	50.70***
	(0.201)	(0.666)	(0.660)	(1.246)
R-squared	0.03	0.052	0.088	0.075
Observations	1,655	1,654	1,645	1,481
F-statistics	F(1, 1653) = 51.23	F(1, 1642)= 48.08	F(1, 1632)= 45.13	F(1, 1465)= 38.6

*Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1*

In the CSRHUB Database, there are four sub-categories of the overall CSRHUB score. These are CSRHUB community, governance, employee, and environmental scores respectively. We replicated the estimations

in OLS(4) and IV(4) in Table 3, using the respective sub-scores instead of the overall CSRHUB score used in the main estimation. The results are presented in Table 5. We generate the same pattern exclusively with all sub-scores that the OLS estimate is much smaller and insignificant while the IV estimation produces a significant and larger coefficient estimate. Specifically, the estimates 0.0052, 0.0041, 0.0040, 0.0039 are very close to the estimate of 0.0041 from the main variable, and all coefficients are larger compared to the OLS estimate of the same coefficient. Therefore, also with sub-scores, we estimate the same effect and the same conclusion prevails in the rationale for using the IV estimation.

Once the information content of the sub-categories of the CSRHUB scores is established, we use the following procedure to test for the effect of a possible measurement error in constructing those variables.

We assume that the potential measurement error is additive. Therefore, we can write the CSRHUB overall measure (SUS) as a function of the true measure SUS* and an independently and identically distributed (iid) error term ξ.

$$SUS = \alpha + SUS^* + \xi$$

Assuming that this specification is valid for the other CSRHUB sub-measures, for instance for the CSRHUB community score as:

$$SUS_c = \alpha_c + SUS_c{}^* + \xi,$$

we get the difference between the measures to eliminate the measurement error under the prevailed assumption.

$$d = SUS - SUS_c = \alpha - \alpha_c + SUS^* - SUS_c{}^*$$

The measure *d*, therefore captures the pure effect of the overall CSRHUB score remaining over the effect of CSR community score, free from measurement error. Based on the test, when we use *d* instead of the overall CSRHUB score, we should at least get the same trend in the coefficients as we go from OLS to IV. In Table 6, we report the findings from this specification along with the OLS(4) and IV(4) from Table 3 in columns 1A and 1B. The variable Gmeasure is the empirical counterpart of the variable *d* above. The results in columns 2A and 2B show that the same trend prevails. The OLS coefficient of 0.0023 increases to 0.181 in the IV estimation. We take this evidence as that the measurement error does not change our conclusion about the effect of unobserved productivity. Still the IV corrects for the downward bias in the OLS estimation, which can only be consistent with that the negative bias is created by the unobserved productivity effect. The IV estimation therefore, corrects mainly the downward bias due to the productivity bias. In Hypothesis 4, stating the measurement error does not play a significant role in estimating the effect of sustainability on financial performance, we state generalize this conclusion.

Table 5: OLS and IV Regressions of Financial Performance (ROA) on sub- CSRHUB scores (CSR community, governance, employee, and environmental scores)

Dependent variable: roa2013								
	OLS (S1)	IV (S1)	OLS (S2)	IV (S2)	OLS (S3)	IV (S13)	OLS (S4)	IV (S4)
community_csr	0.000275	0.00526**						
	(0.000215)	(0.00264)						
governance_csr			0.000213	0.00411**				
			(0.000195)	(0.00179)				
employees_csr					0.000174	0.00400**		
					(0.000271)	(0.00164)		
environment_csr							0.000259	0.00386**
							(0.000212)	(0.00165)
Age	0.00136	0.00283	0.00117	-0.00055	0.00132	0.00244	0.00139	0.00278
	(0.00174)	(0.00240)	(0.00174)	(0.00224)	(0.00173)	(0.00204)	(0.00174)	(0.00216)
roa2012	0.139**	0.125**	0.140**	0.141**	0.140**	0.134**	0.141**	0.149**
	(0.0567)	(0.0550)	(0.0568)	(0.0578)	(0.0568)	(0.0555)	(0.0569)	(0.0588)
roa2011	0.155***	0.166***	0.154***	0.149***	0.154***	0.146***	0.153***	0.140***
	(0.0487)	(0.0493)	(0.0488)	(0.0494)	(0.0488)	(0.0490)	(0.0488)	(0.0507)
roa2010	0.118***	0.117**	0.118***	0.117***	0.117***	0.115**	0.118***	0.127***
	(0.0413)	(0.0494)	(0.0409)	(0.0414)	(0.0411)	(0.0447)	(0.0410)	(0.0426)
lnemply13	0.00780***	0.0029	0.00782***	0.00358	0.00790***	0.00428	0.00782***	0.00429
	(0.00196)	(0.00356)	(0.00194)	(0.00309)	(0.00193)	(0.00275)	(0.00194)	(0.00285)
lnasset12	-0.0211***	-0.0163***	-0.0211***	-0.0185***	-0.0214***	-0.0229***	-0.0213***	-0.0204***
	(0.00369)	(0.00490)	(0.00369)	(0.00434)	(0.00367)	(0.00390)	(0.00369)	(0.00431)
lnmv12	0.0253***	0.0260***	0.0250***	0.0191***	0.0252***	0.0234***	0.0253***	0.0267***
	(0.00364)	(0.00403)	(0.00367)	(0.00476)	(0.00365)	(0.00389)	(0.00366)	(0.00435)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.0618***	-0.356**	-0.0548***	-0.218***	-0.0541***	-0.237***	-0.0601***	-0.264***
	(0.0220)	(0.159)	(0.0186)	(0.0807)	(0.0203)	(0.0838)	(0.0206)	(0.0983)
R-squared	0.34	0.116	0.34	0.161	0.34	0.24	0.34	0.183
Observations	1,503	1,492	1,502	1,492	1,502	1,492	1,503	1,492

Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

6.4. Results with ROE

We repeated the same set of OLS regressions and IV estimations for the dependent variable with the financial returns measured by ROE instead of ROA. The results are given in the appendix in tables A1 to A3. The first result that emerges from the ROE estimates is that we can observe exactly the same pattern as with the ROA estimates. Therefore, the same conclusions can be drawn regarding the causal effect of sustainability on financial returns in a company. ROE estimates with IV estimation are, however, somewhat less precise. Upon examining Table A1 in the appendix, we see that the respective coefficients for the effect of CSR score are 0.45% and 0.57%, 0.45% and 0.54% respectively for IV(1), IV(2), IV(3) and IV(4), but other than IV(2), the coefficients are not statistically significant at the 5% level. Nevertheless, the results still suggest that the OLS estimates are biased downward and underestimate the true relationship between financial returns and sustainability. Particularly in the OLS(4) and IV(4) estimates, the estimated coefficients of 0.00156 and 0.00538 indicate a 3.5 fold difference in the effect of CSR on financial returns. Also comparing the IV estimates obtained using ROE with those obtained using ROA, the estimated effects using the specification IV(4) prevails as 0.406% versus 0.538% for ROA and ROE respectively. This result can be interpreted as the causal effect of sustainability on financial returns as the effects of one-point increase in the CSR score on the ROA and ROE.

We ran the same extensive set of robustness checks to address the properness of our IV. We find that the instrument validity is not a concern. The J-test result of 0.326484 (with p-value = 0.5677) is obtained after replicating the estimation IV(4) in Table A1, by adding the second instrument in the first stage. The null hypothesis of no correlation between the instruments and the error term cannot be rejected at 10% confidence level, suggesting the instruments are safe to be used as exogenous.

In terms of the measurement error, the results with sub-scores of CSR are presented in Table A2. We observe the same pattern exclusively with all sub-scores that the OLS estimates are much smaller than the IV estimates. Specifically, the estimates 0.00639, 0.00693, 0.00524, 0.00533 are very close to the estimate of 0.00538 from the main variable and all coefficients are large compared to the OLS estimate of the same coefficient, which are 0.00060, 0.00114, 0.00065 and 0.00060 for subcategories and 0.00156 for the main variable. With the assumption of additive measurement error, in Table A3, we report the findings from the measurement error corrected specification along with the OLS(4) and IV(4) from Table A1. The results in columns 2A and 2B in Table A3 show that the same trend we found in Table A1. The OLS coefficient of 0.00498 increases to 0.22300 in the IV estimation.

Table 6: OLS and IV Regressions of the Measurement Error Corrected CSRHUB score

Dependent variable: roa2013				
	1A	1B	2A	2B
overall_csr	0.0005	0.00406**		
	(0.000316)	(0.00167)		
Gmeasure			0.0023	0.181*
			(0.00470)	(0.106)
Age	0.00141	0.00194	0.00133	0.00174
	(0.00175)	(0.00194)	(0.00175)	(0.00302)
roa2012	0.140**	0.139**	0.140**	0.180**
	(0.0569)	(0.0566)	(0.0572)	(0.0728)
roa2011	0.157***	0.150***	0.157***	0.119*
	(0.0498)	(0.0494)	(0.0500)	(0.0661)
roa2010	0.117***	0.119***	0.116***	0.129***
	(0.0419)	(0.0435)	(0.0416)	(0.0452)
lnemply13	0.00766***	0.00422	0.00815***	0.00908***
	(0.00196)	(0.00274)	(0.00194)	(0.00335)
lnasset12	-0.0209***	-0.0197***	-0.0211***	-0.0240***
	(0.00374)	(0.00406)	(0.00371)	(0.00601)
lnmv12	0.0247***	0.0234***	0.0249***	0.0288***
	(0.00371)	(0.00399)	(0.00369)	(0.00623)
Industry Dummies	Yes	Yes	Yes	Yes
Constant	-0.0705***	-0.253***	-0.0448***	-0.0393
	(0.0234)	(0.0910)	(0.0170)	(0.0253)
R-squared	0.34	0.273	0.339	
Observations	1,491	1,481	1,491	1,481

Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

We reach the same conclusion from these additional regressions and IV estimations, supporting the view that the marginal cost of sustainability initiatives is higher for the firms that are more productive.

7. Conclusion

In the literature no consensus has yet been reached on the direction of the link between corporate sustainability performance and corporate financial performance. The existing studies mostly focus on establishing the relationship using different measures from various datasets, and employ different estimation techniques. In most of these studies, the empirical results are then argued in the context of the sign, magnitude, and statistical significance of the coefficient of sustainability performance in a regression setting. However, given the potential endogeneity problem in the relationship, it is important to start the analysis by theoretically studying possible sources of any bias that may exist in the OLS estimation of the relationship. For this aim, we hypothesized that the effect of sustainability initiatives on financial performance is actually positive but can potentially be blurred by the endogeneity. In fact, studying two sources of bias, we establish that firms undertaking sustainability initiatives perform financially better than their counterparts, which do not undertake sustainability initiatives using an IV strategy. We employed both OLS and IV methodology for comparison and found out that the OLS underestimates the effect of sustainability on ROA (similarly for ROE). Therefore, in the empirical analysis OLS produces coefficient estimates which are lower in magnitude and also mostly statistically insignificant due to attenuation.

Next, from a general econometric perspective of unobserved factors, we defined the sources of endogeneity in terms of factors related to firm performance. Relying on this framework, we first hypothesized that correlation between a firm's unobserved productivity level and its marginal cost of sustainability initiatives is a potential channel that biases the OLS coefficient. However, it was not clear theoretically whether this will lead to an upward or a downward bias, therefore this could only be identified empirically. The estimation revealed that the marginal costs of sustainability initiatives are higher for the firms that are more productive so the OLS estimation of the effect of sustainability will be biased downward. We argue that, productive companies would be more reluctant to invest in sustainability. We believe that this finding contributes to the innovation adoption literature as well.

Secondly, we identified the comparative advantage bias another possible mechanism for endogeneity. Observing that firms with higher financial returns to their sustainability initiatives, have the incentive to

undertake more sustainability initiatives, we deducted that cross-sectional estimates of the effect of sustainability are likely to yield upward biases in an OLS estimation. Therefore, in our empirical analysis, we construct our hypothesis to test the relative strength of this upward bias in comparison with the bias from the unobserved productivity. The estimation results let us conclude that the productivity bias should lead to an underestimation.

Finally, we benefited from the sub-category measures of CSR Hub to rule out the effect of any possible measurement error. This reinforced our methodological conclusions about the productivity and comparative advantage biases.

There are also several opportunities for future research. We plan to address the mechanism behind the productivity bias by constructing an economic model of the firm behavior regarding sustainability. Model's predictions, simulations, and possibly testable implications will put more evidence on the particular mechanism and suggest a way to think about how sustainability affects the financial returns within a firm. Lastly, from an econometrical perspective, this study utilizes IV methodology under the assumption of homogeneous returns across companies. A natural extension is to account for the heterogeneity in returns to sustainability across firms. This is a nontrivial extension and requires designing the mechanisms for sample selection in addressing the return heterogeneity. The results from such research can be important to further improve our understanding of the dynamics behind the firm behavior in sustainability initiatives.

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Appendix:

Results with ROE

Table A1: OLS and IV Regressions of Financial Performance (ROE) on CSRHUB score (CSR overall score)

Dependent variable: roe2013								
	OLS (1)	IV (1)	OLS (2)	IV (2)	OLS (3)	IV (3)	OLS (4)	IV (4)
overall_csr	0.00324***	0.00456	0.00170***	0.00575**	0.00113*	0.0045	0.00156**	0.00538
	(0.000741)	(0.00376)	(0.000596)	(0.00281)	(0.000606)	(0.00321)	(0.000658)	(0.00370)
age			0.00868*	0.00928**	0.00645	0.00793*	0.00552	0.006
			(0.00458)	(0.00465)	(0.00448)	(0.00455)	(0.00453)	(0.00469)
roe2012			0.573***	0.568***	0.563***	0.562***	0.498***	0.496***
			(0.0526)	(0.0525)	(0.0526)	(0.0526)	(0.0570)	(0.0570)
roe2011			0.102***	0.0962***	0.0981***	0.0941***	0.0972***	0.0923***
			(0.0331)	(0.0340)	(0.0330)	(0.0337)	(0.0346)	(0.0356)
roe2010							0.00408	0.00424
							(0.00258)	(0.00297)
lnemply13					0.0133***	0.00944*	0.0201***	0.0167***
					(0.00344)	(0.00487)	(0.00540)	(0.00624)
lnasset12							-0.0343***	-0.0342***
							(0.00751)	(0.00769)
lnmv12							0.0359***	0.0355***
							(0.00681)	(0.00696)
Industry Dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.0920**	-0.163	-0.150***	-0.363**	-0.133***	-0.308*	-0.157***	-0.350*
	(0.0407)	(0.202)	(0.0359)	(0.150)	(0.0356)	(0.168)	(0.0458)	(0.191)
R-squared	0.012	0.01	0.333	0.315	0.34	0.328	0.354	0.338
Observations	1,604	1,590	1,603	1,589	1,594	1,580	1436	1425

Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

Using the specification in IV(4) in Table A1, we run a J-test after replicating the estimation by adding the second instrument in the first stage. In the full relevance, we expect any instrument used to produce the same parameter estimates from the IV regression and J-test relies on this assumption to test the relevance. The null hypothesis states no correlation between the instruments and the error term. The test of over identifying restrictions on IV(4) with two instruments has produced a test score of 0.326484 (p = 0.5677).

Therefore, we cannot reject the null at 90% confidence level, suggesting the instruments used are exogenous to some extent.

Table A2: OLS and IV Regressions of Financial Performance (ROE) on sub- CSRHUB scores (CSRHUB community, governance, employee, and environmental scores)

Dependent variable: roe2013								
	OLS (S1)	IV (S1)	OLS (S2)	IV (S2)	OLS (S3)	IV (S13)	OLS (S4)	IV (S4)
community_csr	0.0006	0.00639						
	-0.00048	-0.00446						
governance_csr			0.00114**	0.00693				
			-0.000514	-0.0047				
employees_csr					0.000646	0.00524		
					-0.000605	-0.00344		
environment_csr							0.000602	0.00533
							-0.000449	-0.00348
age	0.00528	0.00698	0.0046	0.00206	0.00521	0.00596	0.00535	0.00717
	-0.00451	-0.00506	-0.00447	-0.00533	-0.00451	-0.00474	-0.0045	-0.00495
roe2012	0.495***	0.475***	0.497***	0.498***	0.496***	0.488***	0.499***	0.508***
	-0.0569	-0.0596	-0.0566	-0.057	-0.0569	-0.0577	-0.0568	-0.0576
roe2011	0.0990***	0.111***	0.0959***	0.0873**	0.0966***	0.0882**	0.0963***	0.0838**
	-0.034	-0.0364	-0.0341	-0.0362	-0.0342	-0.0364	-0.0342	-0.0362
roe2010	0.00412	0.004	0.00419	0.00448	0.0041	0.00385	0.00422*	0.00502*
	-0.00256	-0.00347	-0.00261	-0.00334	-0.00254	-0.00294	-0.00252	-0.00283
lnemply13	0.0207***	0.0148**	0.0202***	0.0145**	0.0207***	0.0166***	0.0208***	0.0167***
	-0.00543	-0.00691	-0.00535	-0.00716	-0.00541	-0.00613	-0.00536	-0.00622
lnasset12	-0.0349***	-0.0308***	-0.0348***	-0.0330***	-0.0356***	-0.0379***	-0.0354***	-0.0363***
	-0.00739	-0.0083	-0.00743	-0.00828	-0.00744	-0.00788	-0.0074	-0.0077
lnmv12	0.0379***	0.0404***	0.0361***	0.0287***	0.0373***	0.0354***	0.0380***	0.0416***
	-0.00674	-0.00723	-0.00681	-0.00953	-0.00672	-0.00714	-0.00672	-0.00736
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.117***	-0.461*	-0.128***	-0.365*	-0.112**	-0.328**	-0.115***	-0.379*
	-0.0449	-0.266	-0.0386	-0.197	-0.0455	-0.166	-0.0404	-0.198
R-squared	0.353	0.296	0.355	0.281	0.353	0.325	0.353	0.302
Observations	1,448	1,436	1,447	1,436	1,447	1,436	1,448	1,436
Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1								

Table A3: OLS and IV Regressions of the Measurement Error Corrected CSRHUB score

Dependent variable: roe2013				
	1A	1B	2A	2B
overall_csr	0.00156**	0.00538		
	(0.000658)	(0.00370)		
Gmeasure			0.00498	0.223
			(0.0108)	(0.163)
age	0.00552	0.006	0.00536	0.00692
	(0.00453)	(0.00469)	(0.00451)	(0.00558)
roe2012	0.498***	0.496***	0.501***	0.551***
	(0.0570)	(0.0570)	(0.0574)	(0.0711)
roe2011	0.0972***	0.0923***	0.0984***	0.055
	(0.0346)	(0.0356)	(0.0346)	(0.0499)
roe2010	0.00408	0.00424	0.00402*	0.00441*
	(0.00258)	(0.00297)	(0.00244)	(0.00239)
lnemply13	0.0201***	0.0167***	0.0215***	0.0231***
	(0.00540)	(0.00624)	(0.00544)	(0.00654)
lnasset12	-0.0343***	-0.0342***	-0.0345***	-0.0403***
	(0.00751)	(0.00769)	(0.00748)	(0.00970)
lnmv12	0.0359***	0.0355***	0.0362***	0.0433***
	(0.00681)	(0.00696)	(0.00677)	(0.00947)
Industry Dummies	Yes	Yes	Yes	Yes
Constant	-0.157***	-0.350*	-0.0774**	-0.0723*
	(0.0458)	(0.191)	(0.0354)	(0.0435)
R-squared	0.354	0.338	0.352	0.121
Observations	1,436	1,425	1,436	1,425

Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1