Resource Efficiency and Firm Value

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Abstract

Resource efficiency is the use of fewer resources to produce one unit of revenue. This paper investigates the relationship between firms' resource efficiency and value using Osmosis Investment Management's innovative proprietary Resource Efficiency Score (*RES*). We argue that resource efficient firms hold additional intangible beneficial characteristics that deliver financial performance, as suggested by the resource based view of the firm. The *RES* can also be interpreted as a measure of the social value of environmental sustainability and so we also test whether firms can create shared value. We document strong evidence that the Osmosis mutual funds comprising the most resource efficient firms earn considerable risk adjusted returns. Resource efficiency is positively related to subsequent value with high statistical and economic significance. This result holds consistently across international firms, for various econometric tests controlling for selection bias, endogeneity and reverse causality and is robust to the inclusion of control variables and competing value generating factors. Following similar econometric rigour, we show that high *RES* is also significantly related to higher credit ratings. Our findings lend support to the principles of the resource based view of the firm and shared value theories and we look forward to exploring the underlying mechanisms in future research. Our results show significant returns to investors, value for shareholders, lower risk for creditors and benefits to society through sustainability. The mutually reinforcing relationship between sustainability and economic value should encourage innovation and entrepreneurship in this important area.

Key Words: Corporate social responsibility, Resource efficiency, Fund performance, Firm value, Credit ratings, Resource based view, Shared value theory.

JEL classification: G1, G3, M14.

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1 INTRODUCTION

Socially responsible investing (SRI) or values-based investing strategies have been growing rapidly over the last two decades. By 2012, some 1,100 fund managers had signed up to the United Nations Principles for Responsible Investment, whilst in the US, according to the Forum for Sustainable and Responsible Investment, one in every nine dollars is now under management at dedicated socially responsible funds. This trend has been well documented in many academic studies and professional reports and represents the growing interest and demands of investors for strategies that promote ethics, society and the environment whilst also making returns. In academic research, there is a sizeable literature on the investment performance appraisal of socially responsible investment strategies and an enormous body of work dedicated to studying Corporate Social Responsibility (CSR). The CSR literature encompasses management theory that influences corporate strategy and an enormous volume of empirical studies seeking consensus on whether ethical objectives of stakeholders are aligned with the economic motivations of accounting performance and shareholder value.

A subset of CSR and SRI is the principle of sustainability, which has received far less attention until recently. Sustainability itself incorporates many themes, including resource efficiency, innovation, managerial skill and foresight and shared value, the notion that social and economic value are not mutually exclusive. Given economies', consumers' and corporations' increasing demands for scarce natural resources, resource efficiency is quickly taking a leading role in the promotion and analysis of sustainability. At government and regulatory levels, in the UK a group of Members of Parliament recently commissioned a report which made ten key recommendations to improve productivity and efficiency across the UK economy. These included making resource productivity a priority, establishing resource productivity and efficiency metrics, and enhancing financing for companies implementing resource efficiency measures. The underlying philosophy suggests that the resource aware, efficiency focused and productivity driven economies will set the new standard by which competitiveness will be judged (2020 Productivity and Efficiency Group, 2014). In Europe, the European Commission and several EU member states are developing dedicated resource efficiency policy frameworks as a response to increasing natural resource scarcities (Jansen, 2013). Proponents of resource efficiency advocate that it is a mechanism for enhancing economic value by considering the cyclicality of resources; increasing regulatory pressure on companies may be an effective way for firms to adopt resource efficiency measures (Rademaekers, 2011).

Osmosis Investment Management LLP adopt a different view. They are an award winning, specialist, independent asset management company that uses resource efficiency as their primary investment criterion.[1] As noted in their literature and confirmed by the Harvard Business Review, 'resource efficient companies - those that use less energy and water and create less waste in generating a unit of revenue - tend to produce higher investment returns than their less resource efficient rivals' (Heyns, 2012). The evidence suggests that Osmosis have found a new environmental screen for constructing portfolios that delivers excess returns, thereby contributing to the existing SRI performance appraisal literature (Renneboog et al., 2008a; 2008b; Edmans, 2011; Guenster et al., 2011). However, deeper thought and analysis reveals far more ambitious claims. Osmosis' proprietary firm-level Resource Efficiency Score (RES) constitutes energy, water and waste components such that it provides an objective and numeric measure of sustainability rather than a subjective ranking of firms' environmental performance, thus allowing investors access to investment products focused on sustainability in the form of low carbon firms. At the same time, Osmosis contend that their RES, as a proxy for sustainability, also serves as an identifier of firms with superior management quality, in their forward looking, innovativeness and entrepreneurial attributes that enable them to develop significant competitive advantages, and ultimately firm value. It is this reasoning, together with the documented success of Osmosis' funds, which describes social and economic values as mutually reinforcing (virtuous circle). This provides a strong argument that there need not be a tradeoff between sustainability and shareholder value, and that innovation and productivity in sustainability could generate its own economic rewards without the need for regulatory or policy intervention.

In parallel to, and in support of these developments, there are theoretical advances in the academic literature. The earlier arguments that firms should pursue CSR policies and activities were formed in stakeholder theory (Freeman, 1984) suggesting that firms could develop efficiencies and advantages that generate long term value by engaging with a range of stakeholders rather than satisfying only shareholders as the main group of stakeholders. Instrumental stakeholder theory (Jones, 1995) extended this reasoning arguing that CSR action and strategy for the benefit of all stakeholders is instrumental for financial performance. The mechanisms by which CSR influences firm performance and value involve developing the firm's external reputation and image and enhancing its internal strengths, resources and capabilities (or both).

The internal mechanisms relate to the resource based view of the firm (Porter, 1985; Barney, 1991), which links directly to Osmosis' resource efficiency concept. We believe that resource efficient firms posses beneficial resources, capabilities and competencies that help them counter the horizontal and vertical threats to the firm described in Porters (1980) model. Furthermore, the resources that these firms hold in the form of technological knowledge, expertise, innovativeness and skill coupled with managerial

[1] Osmosis were awarded the 'Innovation in Climate Change Investment' award at the 2010 Climate Change Awards.

quality and employee goodwill have the properties of being inelastic in supply, are difficult to develop quickly, are non-tradeable, valuable, rare, inimitable, and not substitutable, which the literature argues are required for firms to develop competitive advantages (Dierickx and Cool, 1989; Barney, 1991; 2001; McWilliams and Siegel, 2011). More recently, attention in the theoretical literature has turned to sustainability in the form of the shared value theory (Porter and Kramer, 2006; 2011). This argues that social value and economic value are symbiotic and mutually reinforcing, so firms should strive to create economic value in ways that also create social value. The important implication is the encouragement of innovation and productivity in many areas of firms operations, with sustainability featuring heavily. Efficiency in resource utilisation is one way through which firms are able to boost productivity in the value chain, which is precisely the mechanism that Osmosis detect in their resource efficiency score. The accompanying empirical tests of sustainability (Eccles et al., 2012; Eccles and Serafeim, 2013; Eccles et al., 2014) represent new and exciting progress and it is to this literature that we hope to contribute.

Our work tests the hypothesis that sustainability in the form of resource efficiency, as measured by the Osmosis *RES*, has a positive impact on investment returns and firm value. We confirm the success of the Osmosis funds using rigorous investment appraisal models and this documents a small contribution to the SRI portfolio analysis literature.[2] Contrary to the SRI mutual fund literature, these results highlight a rare success though we are careful to recognize that our results are specific to only one type of fund rather than the average of the full range of mutual funds available to investors. Empirical tests of the influence of CSR on operating performance or firm value are plagued by a number of issues. Statistically, there is measurement error in Corporate Social Performance (CSP) variables, whilst cross sectional tests are hampered by sample selection bias, endogeneity and reverse causality. We believe that the Osmosis *RES* provides the best measure of international, firm-level environmental performance that we are aware of. It is numeric, objective and with inputs measured in clearly defined units, rather than based on binary variables, ranking scales, qualitative inputs and subjective weightings of subcomponents. More importantly, the *RES* can also be interpreted as a measure of social value allowing us to test the principle underlying the shared value theory.

In our cross-sectional tests we are careful to employ appropriate and rigorous methods to ensure that our model is correctly identified. We find a positive relationship between *RES* and firm value which is highly significant in statistical and economic terms. The significance of this relationship is consistent across samples of World, European and US firms and across a barrage of econometric tests. For the US sample, our result is robust to controls for managerial and corporate governance characteristics, non-

[2] For significant results on the environment dimension of CSR see Derwall et al. (2005), Kempf and Osthoff (2007) and Guenster et al. (2011). For portfolios returns based on employee relations see Kempf and Osthoff (2007), Galema et al. (2008), Statman and Glushkov (2009) and Edmans (2011). And for community see Kempf and Osthoff (2007).

environmental CSR performance and information uncertainty. Finally, adopting similar econometric procedures, we find that *RES* is also significantly related to higher credit ratings. Our results have clear implications for investors, but also supports the conjecture that it is possible for firms to develop shared value and that there need not be a tradeoff between sustainability and financial performance.

The remainder of the paper is organised as follows. Section 2 surveys the vast literatures on SRI and CSR and draws out some key themes and recent trends. Section 3 defines the Osmosis *RES* that is so critical to this study and also presents the performance analysis of their funds that motivate the deeper firm-level analysis. Section 4 details the variables, econometric procedures, and results from our analysis of the relationship between firm resource efficiency and value. Section 5 conducts robustness tests to find out whether the influence of *RES* on firm value is maintained and is consistent when controlling for other value generating variables. Section 6 presents similar analysis to that in Section 4, but using credit ratings as the dependent variable. Section 7 offers conclusions and thoughts about how research might proceed in future.

2 RELATED LITERATURE

Osmosis Investment Management uses its innovative and proprietary Resource Efficiency Score (*RES*) to select firms for inclusion into their investment funds. The underlying principle of this approach is that resource efficient firms are able to generate more revenue per unit cost of resources and develop competitive advantages relative to their peers. These are not only profitable, but also may not be fully reflected in market prices and so together represent profitable investment opportunities. This paper tests whether resource efficiency does indeed deliver increased firm value. Since Osmosis screen constituent stocks based on environmental and sustainability factors, their funds can be classified as socially responsible, even though some firms they include may not be strictly ethical according to other definitions. Meanwhile, the approach of firms to resource efficiency relates directly to their strategies in CSR and sustainability, but also indirectly to their efficiency more generally. The academic literatures on socially responsible investing and corporate social responsibility are vast. This brief review attempts to convey the important advances in these areas and explain how our work on resource efficiency contributes.

Socially responsible investment (SRI) is defined as the incorporation of environmental, social and governance (ESG) factors into portfolio construction, the filing or co-filing of shareholder resolutions on ESG issues, or investments that have a specific mission of community investing. According to the first definition, portfolios are constructed using a combination of ethical (ESG) and financial screening. SRI funds aspire to provide investors with a combination of social and financial returns and the growing academic literature analyses fund performance in these regards. Given the variety of social issues that investors are concerned with, the increasing attention and conviction of investors to moral beliefs, greater ethical activism by investors and the range of screening intensity available to portfolio managers, it is not surprising that the professional SRI industry has grown quickly to approximately $3.74 trillion assets under management in the US, a rise of more than 486 percent from $639 billion in 1995 and corresponding to approximately 11.3 percent of the industry (Forum for Sustainable and Responsible Investment trends report, 2012).[3]

A number of studies debate whether ethical screening by mutual funds should affect their performance with these arguments relating to both portfolio constraints and firm-level performance.[4] The striking feature of the empirical research is the extremely scarce evidence that the average professional SRI mutual fund significantly outperforms its benchmark.[5] Indeed, in the most comprehensive, recent study of SRI funds, Renneboog et al. (2008a) find that SRI funds in the US, UK, Europe and Asia-Pacific countries actually under perform their domestic benchmarks, whilst those in France, Japan and Sweden show no significant differences. Very few studies, however, investigate more thoroughly the reasons for this lackluster performance. Derwall et al. (2011) make an excellent development in this regard by segmenting SRI investors into value driven and profit motivated components arguing that negatively screening controversial stocks that are known to perform well places mutual funds at a performance disadvantage, which is offset by the positive screening of socially responsible stocks that outperform. The recent literature investigating hypothetical portfolios (rather than professionally managed funds) formed on highly specific criteria provides supportive evidence that socially responsible stocks significantly outperform, particularly in environment and employee dimensions. Osmosis manages precisely such a fund in the specific screening area of resource efficiency, providing us with an unique opportunity to contribute to the literature by examining a new screening criterion closely related to environment and sustainability issues.

In the context of financial theory, the evidence that socially responsible firms are able to achieve superior performances relies on the ability, or lack thereof, of markets to value CSR. This is further complicated by the intangible nature of the benefits and costs of CSR practices and policies, including

[3]This trend in volume and importance has been mirrored in Europe. The European Sustainable Investment Forum (Eurosif, 2010) reports that total European SRI assets under management are in excess of EUR 5 trillion and are increasing at a rate of around 87 percent every two years.

[4]Negative arguments are provided by Rudd (1981), Grossman and Sharpe (1986), Abowd (1989), Statman and Glushkov (2009) and Barnea and Rubin (2010). For positive arguments see Moskowitz (1972), Kempf and Osthoff (2007), Ghoul et al. (2011) and Edmans (2011). No effect from SRI screening is proposed by Aupperle et al. (1985), Hamilton et al. (1993), Goldreyer and Diltz (1999) and Statman and Glushkov (2009).

[5]See for example Luther et al. (1992), Hamilton et al. (1993), Luther and Matatko (1994), Mallin et al. (1995), Gregory et al. (1997), Statman (2000), Kreander et al. (2005), Bauer et al. (2005) Gregory and Whittaker (2007) and the excellent review of Renneboog et al., 2008b.

difficulties in defining and measuring subjective concepts across multiple dimensions. Hamilton et al. (1993) structures this problem into three possible mechanisms. First, markets may not value CSR at all such that CSR is unrelated to firm value. Second, markets do incorporate CSR into prices so responsible firms are associated with lower risk and possibly higher profitability giving rise to a positive effect on value. Third, the market does not price the intangible nature of CSR efficiently meaning that responsible firms are undervalued initially, but associated with higher value subsequently. Investors can therefore purchase stocks in these companies at prices below their intrinsic values to achieve positive abnormal returns once the intangibles are realized. In an asset pricing or investment performance context, the undervaluation of intangibles gives rise to anomalies described as investment styles that deliver returns that are not captured by popular risk factors. This inability of the market to price accurately intangible assets is likely the result of the use of traditional and outdated valuation methodologies based on physical assets.

The analysis of intangible assets has a long and established history. Prior research has investigated R&D (Lev and Sougiannis, 1996; Chan et al., 2001), innovation (Deng et al., 1999), technology (Aboody and Lev, 1998; Bharadwaj et al., 1999), advertising (Chan et al., 2001), customer satisfaction and sentiment (Luo, 2007; Aksoy et al., 2008) and firm reputation (Deephouse, 2000; Roberts and Dowling, 2002) all finding significant relationships with returns, value or performance. The examination of CSR has been much more recent, documenting similar significant risk adjusted returns for environment (Derwall et al., 2005; Kempf and Osthoff, 2007; Guenster et al. 2011), employee (Kempf and Osthoff, 2007; Galema, 2008; Statman and Glushkov, 2009; Edmans, 2011;) and community (Kempf and Osthoff, 2007) dimensions. In sum, the empirical evidence lends support to the case that the market is unable to price intangibles. The success of Osmosis' funds suggests that investors can achieve similar positive abnormal returns by investing in resource efficient firms. Consistent with this prior research, resource efficiency appears to represent an alternative undervalued intangible asset within the environment dimension of CSR. We contribute to this literature by analysing the relationship between this new resource efficiency metric and firm value.

Of course this work falls into the more general literature that investigates the importance of CSR to firms. This incorporates a vast number of empirical studies exploring the link between CSR and firm value and operating performance and so we benefit from meta-analysis (Orlitzky et al., 2003)) and literature reviews (van Beurden and Gössling, 2008) to develop consensus findings.[6] In addition to the portfolio approach discussed above, the other empirical evidence can be separated between event studies (including disclosure effects) and the far more accessible and popular regression based studies investigating links

[6] For other meta-analyses on this issue, see Allenche and Laroche (2005), Wu (2006) and Margolis et al. (2007).

between CSP and market measures of value or accounting measures of performance. Since disclosure of CSR practices is partly voluntary, the decision to disclose may itself convey information regarding CSP quite apart from the details disclosed, which may also impart sample selection bias into empirical tests. Voluntary disclosure theory (Bewley and Li, 2000) and legitimacy theory (Patten, 1992; Gray et al., 1995, 1996) present opposing views on the direction of the relationship between CSP and the level of disclosure. Studies of disclosure effects on financial performance suggest that disclosure is associated with higher stock returns and profitability (Jo and Kim, 2008; Gamersschlag et al., 2011), whilst the specific disclosure of CSR performance reduces the cost of equity, increases analyst coverage and lowers absolute forecast errors and dispersion, signaling lower information uncertainty (Dhaliwal et al., 2011; 2012). Other event studies suggest that share prices react to CSR related news. As noted by Derwall et al. (2011) and Guenster et al. (2011) these are primarily studies of events relating to environmental performance. The market reacts positively (negatively) to good (bad) news of environmental performance in the form of policy or events.[7] However, more recent results show asymmetric reactions in that negative returns following bad news are larger in absolute terms than positive reactions to good news (Karpoff et al. 2005; Krüger, 2009). This demonstrates support for the notion that the market is unable to value the intangible benefits of CSR.

The theories considering the benefit of CSR on firms' performance give conflicting perspectives and this has spurred a huge empirical literature. This evidence has subsequently provided seemingly inconclusive results. Whilst Waddock and Graves (1997) and Hillman and Keim (2001) document supportive results, this is tempered by Wright and Ferris (1997) and Luo and Bhattacharya (2006) who show a negative relationship and Aupperle et al. (1985) and Teoh et al. (1999) who find no meaningful association. However, selecting individual studies from such a vast literature is limited and potentially biased. The literature review of van Beurden and Gössling (2008) is a more comprehensive means to garner a consensus view. They find clear evidence of a positive correlation between CSP and Corporate Financial Performance (CFP). Alternatively, Orlitzky et al. (2003) criticize the use of literature reviews and advocate meta-analysis as a more appropriate and refined method. They argue that interpretation of the results of numerous empirical tests is plagued by many problems such as ambiguity surrounding the direction and dynamic of causality between CSP and CFP (temporal sequence), identification of the mediating relationships explaining the influence, variations in the correlation across studies due to the misalignment of CSP variables with appropriate stakeholders and statistical biases in the form of sampling and measurement errors induced by the choice and measurement of CSP and CFP variables (moderators). Recognising these effects, Orlitzky et al. (2003) find positive results, though the causality

[7] For further details see Shane and Spicer (1983); Blacconiere and Patten (1994); Hamilton (1995); Klassen and McLaughlin (1996); Al-Tuwaijri et al. (2004); Brammer and Pavelin (2006, 2008); and Jacobs et al. (2010).

relationship between CSP and CFP is bidirectional and simultaneous, with the strength of the association moderated by stakeholder mismatching and sampling and measurement bias. Motivated by these insights into the empirical problems, this study contributes to this literature by incorporating the *RES* that is free from some statistical biases and by implementing appropriate techniques to control for others and uncover the causality of the relationship. More recently, researchers have extended this literature to consider the relationship between CSP and credit risk. These studies find consistent evidence that CSP is rewarded by lower credit risk and hence cost of debt, as indicated by lower yields and credit spreads and higher credit ratings, lower bankruptcy risk, lower debt ratios and better access to finance (Bauer et al., 2009; Verwijmeren and Derwall, 2010; Bauer and Hann, 2010; Goss and Roberts, 2011; Attig et al., 2013; Oikonomou et al., 2014; Cheng et al., 2014).

The theoretical arguments for the relationship between CSR and financial performance combine financial economics and strategic management theories that explain the alignment of the benefits of CSR with shareholder value. These are summarised by Orlitzky et al. (2003) and Flammer (2013a; 2013b). The contrasting views are characterized by the debate between shareholder value maximization (Friedman, 1962; 1970) and agency cost (Jensen and Meckling, 1976) theories that CSR reduces shareholder value, versus stakeholder theory (Freeman, 1984) that suggests firms engaging with a broader group of stakeholders develop efficiencies and advantages that ultimately deliver value. One extension of this is the instrumental stakeholder theory (Jones, 1995) arguing that CSR activity that benefits a broad range of stakeholders is instrumental for financial performance. CSR allows managers to increase the firms efficiencies and competitive advantages by addressing and balancing the claims of multiple stakeholders in a fair and rational manner ('good management theory'). The slack resources theory supports the positive correlation between CSP and CFP, but argues that the causality runs in the opposite direction such that high financial performance delivers slack resources that can then be used to engage in CSR.

CSP can influence CFP by affecting the firms external reputation or internal competencies and resources. According to Orlitzky et al. (2003), a firm's engagement in CSR can develop reputation and enhance the firm's image when communicated to its external stakeholders. Good CSP performance can then attract new customers and better employees and improve access to and the cost of capital, which ultimately benefit financial performance. Internal benefits stem from the resource based view of the firm (Rumelt, 1984; Porter, 1985; Barney, 1991). Within this framework, firms are able to generate sustained competitive advantages through implementing strategies which exploit or develop internal strengths, or by responding to external opportunities or threats. The internal strengths are competencies, resources and capabilities in areas such as management, information technology (Mata et al., 1995), and human resources (Wright et al., 1994). More specific to CSR, and particularly in the context of resource efficiency, firms are able to develop competitive advantages by implementing effective environmental and sustainability strategies and technologies (Hart, 1995; Shrivastava, 1995; Russo and Fouts, 1997; McWilliams and Siegel, 2001; 2011). We, along with Osmosis, believe that this paradigm explains how resource efficient firms are able to generate competitive advantages that ultimately deliver firm value. More notably, this view links directly to the shared value theory of Porter and Kramer (2006, 2011), which argues that firms should strive to create economic value in a way that also creates social value. Efficiency in resource utilisation is stated as a precise way through which firms are able to boost productivity in the value chain. In a relatively new and exciting literature, this shared value may also be related to sustainability, as a different concept from CSR (Eccles et al., 2012; Eccles and Serafeim, 2013; Eccles et al., 2014).

This study is most closely related to Derwall et al. (2005) and Guenster et al. (2011). Using an eco-efficiency score produced by Innovest Strategic Value Advisors, they construct portfolios of high and low eco-efficient firms and analyse their performance. The high eco-efficient portfolio delivers excess returns after adjusting for risk. Furthermore, Guenster et al. (2011) show that in cross-sectional tests eco-efficiency is associated with higher operating performance and firm value. We find similar results for our portfolio analysis and hope to contribute to this literature in other ways. First, we apply the Osmosis (RES) to an international sample of firms, which is constructed using objective, numeric inputs rather than the subjective inputs and ranking categories of the eco-efficiency score, thereby attempting to address the measurement problem of CSP studies. Second, we aim to extend their work by considering and resolving possible endogeneity and reverse causality, giving more robustness to our findings. Third, the RES is a more focussed measure of the social value of resource utilisation and therefore can provide a more direct test of the relationship between this area of sustainability and economic value and hence the principle behind the shared value theory.

3 RESOURCE EFFICIENCY FUNDS

3.1 RESOURCE EFFICIENCY SCORE

Osmosis Investment Management specialises in sustainability motivated investment. Their investment strategy, namely the Model of Resource Efficiency (MoRE), stipulates that only firms with the highest levels of resource efficiency can be held within their funds. To facilitate such a strategy, Osmosis have pioneered an innovative valuation metric to quantify the efficiency of a firm's usage of resources. This measure is based on a firm's rate of utilisation in energy, water and waste, and helps formulate their investment decisions. Osmosis collect firm-level resource usage data from various sources, including annual reports, public filings, corporate sustainability reports, public inventory databases and financial database, such as Bloomberg, Factset, Morningstar, and others. The firm-level resource usage data is verified manually and cross-checked with other databases to ensure that the data are reliable. Osmosis focus their research on non-financial firms that have traditional factors of production. Each firm is a constituent of the MSCI World Index and are followed by Osmosis because they have made sufficient disclosures of their usage of energy, water and waste. Their sample of firms covers a wide range of sectors and the total number is slightly over 1,200.

Osmosis' new valuation metric, the Resource Efficiency Score (RES), is the average relative performance of a firm's efficiency in energy, water and waste usage. Energy consumption is measured by the level of absolute emissions of greenhouse gases from fossil fuel combustion, industrial processes and other sources owned or controlled by each company, and is captured by the amount of CO_2e. Water efficiency is measured as the costs generated by water utilised in operations taken directly from the ground, surface waters or purchased from local authorities. Waste efficiency is measured as the costs generated from the disposal of waste in normal company operations, classified as landfill, incinerated waste, recycled or nuclear waste. Each metric is then scaled to generate a factor score for each component, which measures the rate of utilisation relative to a firm's total revenue. A lower factor score represents higher efficiency since for each unit of revenue generated, the resource usage is lower. To account for the heterogeneity across sectors, the factor scores are standardised by subtracting the industry mean and dividing by its cross-sectional standard deviation to obtain three z-scores for energy, water and waste efficiency for each firm. The three z-scores are averaged, weighted equally, to form a composite score which is then re-scaled to ensure that a firm with higher resource efficiency has a higher RES. This valuation metric differs from the widely used ESG data which, as noted by Edmans (2011), is relatively subjective and qualitative. More specifically, the data used by Osmosis in constructing the RES is entirely based on objective and quantitative corporate data.

3.2 PERFORMANCE OF THE MoRE FUNDS

In August 2011, Osmosis launched their flagship fund, the Osmosis MoRE World fund (Ticker: MOREWOUT). Osmosis rank stocks according to their RES within each industry and invest in the top decile with more or less an equal weighting. They also maintain four indicative fund portfolios for US, UK, Japanese and European firms separately. Osmosis provided us with the monthly series of returns of the MoRE World fund and the US, UK, Japanese and European MoRE stock portfolios from January 2005 to December 2013. For the traded MoRE World fund before August 2011 and for the full sample of the regional portfolios returns are based on back-testing. We extend the SRI literature by performing a series performance evaluation tests on these five funds to see whether the MoRE investment strategy centering on resource efficiency delivers significant risk-adjusted abnormal returns. Although closely linked to SRI through sustainability and environmental arguments, we recognise that the main incentive for firms to be resource efficient may be unrelated to ethics, but is perhaps entirely driven by the maximisation of economic value. The MoRE World fund therefore is not officially classified as an SRI fund. However, the intense dedication of their investment philosophy to resource efficiency and sustainability allows us to provide new evidence related to the SRI funds literature in the context of their RES.

The first test is based on the well known Capital Asset Pricing Model (CAPM) specified as follows:

$$R_t = \alpha + \beta_{MKT} R_{MKT,t} + \varepsilon_t, \tag{1}$$

where in our application R_t is the excess return on the Osmosis fund, $R_{MKT,t}$ is the excess return on the benchmark index and ε_t is the regression residual. α is the abnormal return of this fund in excess of the returns expected by the market model, and β_{MKT} measures the portfolio's systematic risk.

The second test applies the Fama and French (1993) three-factor model (FF-3) that extends the simple CAPM to include the familiar size and book-to-market factors in the regression:

$$R_t = \alpha + \beta_{MKT} R_{MKT,t} + \beta_{SMB} SMB_t + \beta_{HML} HML_t + \varepsilon_t, \tag{2}$$

where SMB is the size factor, which measures the premium earned by small firms over large firms, HML is the high-minus-low factor, which captures the value premium earned by high book-to-market firms over low book-to-market firms. The size and book-to-market factors provide a more robust adjustment of returns to conventional risk factors that have a long history in empirical tests, and also allow the portfolio's exposure to various investment styles and systematic risks to be interpreted.

The third test estimates the Carhart (1997) four-factor model (C-4) that includes the momentum factor in addition to the FF-3 model:

$$R_t = \alpha + \beta_{MKT} R_{MKT,t} + \beta_{SMB} SMB_t + \beta_{HML} HML_t + \beta_{WML} WML_t + \varepsilon_t, \tag{3}$$

where WML is the momentum factor, which is the size-adjusted return differential between past winners and losers.

We obtained the monthly size, value and momentum factors and risk free rates for the US, Japan, Europe and Global regions from Prof. Kenneth French's data library. For the UK, the size, value and momentum factors are made available by the Exeter University following the work of Gregory et al. (2013), and the sample period of the UK factors ends in December 2012.[8] The benchmark indices are the S&P500, FTSE 100, MSCI Japan, MSCI Europe and MSCI World indices, all of which exclude financial companies. We are careful to select region-specific risk factors to ensure an accurate and appropriate adjustment for risk for each fund's performance. We also performed robustness checks using the broader market portfolios and find qualitatively similar results.

[Insert Table 1 about here]

The results from the three tests are reported in Panels A, B and C of Table 1 and a number of interesting findings emerge. First, the results across the three models are remarkably consistent in documenting strong evidence that the MoRE funds have significant and positive alphas over this sample period. In the most restrictive C-4 model, the abnormal returns range from 30 basis points per month in the Japanese fund to 70 basis points per month for the World fund, with alphas across all regions significant at the 5% level or higher. The equivalent annualised risk-adjusted abnormal returns are approximately 4.8%, 6.0%, 3.6%, 7.2% and 8.4% for the US, UK, Japanese, European and World funds, respectively. This striking evidence of such economically significant abnormal returns clearly contradicts the majority of the existing SRI funds literature and shows that, by screening funds based on resource efficiency, it is possible to outperform the benchmark indices. Second, the UK and Japanese MoRE funds have relatively low systematic risks as measured by an estimate of β_{MKT} lower than one, while the US, European and World funds have slightly more market risk. The R^2 measures for all five funds are close to 0.90 indicating that the portfolio returns follow their benchmarks quite closely, meaning that the funds are diversified to similar levels as their benchmarks. Third, all funds have a positive and significant loading on the SMB factor indicating that the MoRE strategy may have a slight tilt towards smaller firms. Fourth, the loadings on the momentum factor are consistently negative and significant in all five funds, which may suggest that the funds have identified undervalued firms with lower recent past performance.[9]

These results confirm the success of the Osmosis MoRE investment strategy and show that funds can outperform when screening according to resource efficiency. From an investment perspective, a firm's level of resource efficiency may present an unique characteristic for investors to identify efficient firms

[8] We are very grateful that Prof. Kenneth French and Gregory et al. (2013) make these data available online.

[9] For comparability with Derwall et al. (2005) and Guenster et al. (2011), we also analyse the performance of the RES sorted portfolio returns. Consistent with their results, we find higher returns for portfolios with higher RES firms compared to low RES firms. We do not show these findings for brevity since we prefer to report the analysis for the MoRE funds that are available to investors.

with competitive advantages or firms with intangible assets that are currently undervalued. The strong economic and statistical significance of the performance of these specific portfolios motivates us to pursue a deeper investigation of the relationship between RES and firm value.

4 RESOURCE EFFICIENCY AND FIRM VALUE

Our main hypothesis is that a firm's resource efficiency is positively associated with future firm value. We argue that resource efficiency is not only important for sustainability, but is also a channel through which firms can lower costs, develop competitive advantages, create valuable intangible assets and improve shareholder value. Affirmative evidence may then influence firm management to prioritise resource efficiency in their strategic management, for the long-term interests of sustainability and also for the financial interests of the firm's shareholders. Resource efficiency may not be a priority for firms currently. The existing literature (see for example Stein, 1988, Edmans, 2009, 2011) suggests this is due to managerial myopia where managers under invest in intangible assets because they are invisible to the majority of shareholders. The significant influence of resource efficiency on shareholder value may prompt shareholders or independent directors to encourage management to implement strategies that improve their resource efficiency for financial as well as environmental reasons.

4.1 DATA, SAMPLE AND VARIABLE CONSTRUCTION

We collect data from a number of sources for the period 2005 to 2012. We use Osmosis Investment Management's proprietary firm-level Resource Efficiency Scores (RES) defined in the previous section. Osmosis' usable dataset covers 876 public firms from 26 countries, all of which are constituents of the MSCI World Index. As one of the first studies to explore the value implications of resource efficiency, we aim to make best use of the extensive coverage of this international firm-level dataset. Our analysis is organised into three geographic samples: World; Europe; and US. The World sample includes all available countries including those from the European and US samples. The European countries include continental Europe, Switzerland, Scandinavia and the UK. Accounting and stock return data for the international and European samples are collected from Thomson Datastream and are denominated in US dollars. For the US sample, all accounting and stock return data is collected from Compustat and the Center for Research in Security Prices (CRSP).[10]

Following the definition and variable construction in He and Tuan (2013), we use Tobin's Q to measure

[10]We also replicate the analysis of the US sample using data collected from Thomson Datastream and the main results remain qualitatively the same.

firm value. This is defined as the market value of equity minus the book value of assets and equity, all divided by the book value of assets. Because of positive skewness, we take the natural log of one plus Tobin's Q ($Ln(Tobin'sQ)$) and use this as the dependent variable. To isolate the influence of RES on firm value, we include numerous control variables that are known to drive firm value, the most obvious being return on assets (ROA) and its lags, computed as the ratio of income before extraordinary items to total assets. We also include research and development expenditure to total assets (RD_A) as a major control variable. Previous evidence shows that RD_A contributes positively to firm performance and market value (see for example Lev and Sougiannis, 1996; Chan et al., 2001; Eberhart et al., 2004). Firm investment is measured by the ratio of capital expenditure to total assets (INV_A). A higher level of investment is expected to be associated with a higher firm value as documented by McConnell and Muscarella (1985). Following Lee et al. (2014), we use a firm's annualised standard deviation of stock returns computed over the 12-month period before its fiscal year-end as a measure of firm risk. We also include leverage and dividend yield according to the evidence that both debt and dividend policy affect firm value (Fama and French, 1998). Asset tangibility, the book value of net property, plant and equipment to total assets (PPE_A) and size, measured by the log-transformed deflated total assets ($Ln(Assets)$) are also included as further control variables.[11]

To control for the effects of managerial and corporate governance characteristics, we collected a number of variables including CEO age, tenure, gender, total compensation to total assets, percentage of stock ownership, and duality, all obtained from the Compustat Execucomp Database which is available for the US sample only. We also obtained information on board characteristics from the Investor Responsibility Research Center, Inc. (IRRC), including board size, independence, average independent directors' tenure, gender, age and percentage of stock ownership.[12]

To disentangle the effect of resource efficiency from other intangibles or ESG factors, we use the widely-applied Kinder, Lydenberg and Domini (KLD) data to measure a firm's corporate social performance (CSP) in our analysis.[13] The KLD variables evaluate a firm's performance in six dimensions of CSP: product; employees; diversity; community; corporate governance and environment. Within each dimension, KLD classifies various aspects of CSP into binary variables representing strengths and concerns separately. We include only the first four dimensions of CSP because we already incorporate a more

[11] The total assets of the world sample are deflated by their respective domestic GDP deflator with a base year of 2009, or otherwise, by their domestic CPI indices. The domestic GDP deflator and CPI indices are downloaded from the Federal Reserve Economic Data (FRED) web site, accessed via: http://research.stlouisfed.org/fred2/. If both the country's GDP deflator and CPI index are not available on the FRED web site, we obtained the information from their respective national census web sites.

[12] A detailed definition of the variables is provided in Table A.1 in the Appendix.

[13] KLD data has been widely used in studies across various literatures as an objective measure of firm CSP. For studies relating to accounting see Kim et al. (2012) and Cho et al. (2013); for studies relating to business ethics see Bird et al. (2007), Bear et al. (2010) and Cai et al. (2011); for finance studies see Galema et al. (2008) and Deng et al. (2013); for general or strategic management studies see Chatterji et al. (2009), Godfrey et al. (2009) and Ramchander et al. (2012).

extensive set of corporate governance factors as explained above. More importantly, the environment dimension is already captured in the RES measure, which is the focus of our study. Following Kempf and Osthoff (2007) and Galema et al. (2008), for a given firm within a fiscal year, we calculate a net CSP score by subtracting the total number of concerns from the total number of strengths for each of the four dimensions. The KLD data is provided by MSCI and covers the period 2005 to 2010. Finally, to control for the effect of investor attention and information uncertainty, we include analyst coverage and forecast dispersion. Following He and Tuan (2013), analyst coverage is measured by the monthly average of the number of one-year earning-per-share (EPS) forecasts over a fiscal year for a given firm. Following Zhang (2006), information uncertainty is measured by the average monthly forecast standard deviation over a fiscal year, scaled by its stock price at the fiscal year-end.[14] We include the log of one plus the coverage and dispersion variables in the regressions because of positive skewness. The analyst data is collected from the summary file of the Institutional Brokers' Estimate System (I/B/E/S). As with the corporate governance variables, KLD and analyst data is available for the US only.

Whilst Osmosis update and recalculate their RES every month when new resource efficiency data is disclosed by industry peers, we specify a firm's RES in year t as its RES as at the end of June in calendar year t to reduce the noise induced by the monthly recalculation of RES. As the independent variables are lagged by one year to help alleviate potential endogeneity bias, we match the firm's year t RES with its fiscal year t+1 value. This matching scheme ensures that the RES value is available before the start of fiscal year t+1 and allows us to focus on the impact of RES on subsequent firm value. We discard any unmerged data and data with missing observations in our fundamental variables. We further screen out observations in which there are negative book values or assets. To reduce the problem of outliers, we winsorised the variables at the 0.5% and 99.5% levels. The final merged dataset for the World, European and US samples consists of 3917 (631), 1385 (237) and 1108 (174) firm-year observations (unique firm entities), respectively.

4.2 SUMMARY STATISTICS

The number of observations, means, standard deviations and percentile statistics for our variables are reported in Panel A of Table 2. The average firm size, as measured by deflated assets, is about $27.9 billion for the full sample, $34.3 billion for the European sample and $30.1 billion for the US sample. While the mean RES is 0.034 for the World sample, the European firms are more resource efficient than the US firms on average with mean RES of 0.053 compared to 0.029. The pairwise correlations between

[14]This scaling is to reduce the problems of heteroscedasticity. A similar approach is used in Zhang (2006) and Bali et al. (2013).

the variables and either log Tobin's Q or RES are reported in the last two columns. The correlations show that RES is positively associated with Tobin's Q, significant at the 5% and 1% level with respect to the World and US samples, respectively. More resource efficient firms have higher leverage, PPE_A, dividend yields in general and tend to be larger. In the World sample, higher RES correlates with lower risk. Specific to the US sample, RES is negatively related to PPE_A, is positively related to average board tenure, board gender diversity, and is associated with lower information uncertainty.

[Insert Table 2 about here]

Panel B of Table 2 shows the distribution of our sample across countries. The final sample includes 22 countries and the three regions with the largest numbers of firms are the US, Europe and Japan, which supports Osmosis' construction of representative funds described in Section 3. This representation also helps guide us to collect firms into regions to allow representative and sizeable samples for our analysis. On average, there are 172 US, 174 European and 134 Japanese firms, constituting 28.3%, 35.4% and 27.2% to the total firm-years. Panel C reports the yearly distribution with an industry breakdown according to the Industry Classification Benchmark (ICB). The five largest contributing industries to firm-years are Technology, Hardware and Equipment (9.93%), Chemicals (9.34%), Industrial Engineering (7.51%), Pharmaceutical and Biotechnology (6.92%) and Automobiles and Parts (5.28%).

Panel D of Table 2 reports the average RES for each country over our sample period. The statistics show that European countries have become noticeably more resource efficient over time with a growth rate of RES considerably higher than the US firms. More specifically, the RES of the European sample increased from 0.018 in 2005 to 0.096 in 2012, equivalent to an annual growth rate of 23.3% while the RES of the US sample (including firms for which we have the requisite data) grew by 1.6%. The top five resource efficient countries on average are Spain (0.231), Italy (0.147), Finland (0.114), UK (0.103) and Austria (0.086) while US is ranked the 11th. Nine out of the ten most resource efficient countries are from our European sample.

4.3 ECONOMETRIC METHODOLOGY

To evaluate the relationship between RES and firm value, we estimate pooled OLS regressions for each geographic sample, with industry, country and year fixed effects and robust standard errors clustered at a firm level. The full model is:

$$\begin{aligned}Ln(Tobin's\ Q)_{i,t} = {} & \alpha_0 + \beta_1 RES_{i,t-1} + \beta_2 ROA_{i,t-1} + \beta_3 ROA_{i,t-2} + \beta_4 ROA_{i,t-3} + \beta_5 RD\_A_{i,t-1} \\ & + \beta_6 (RD\_A \times RES)_{i,t-1} + \beta_7 INV\_A_{i,t-1} + \beta_8 Ln(\sigma^{TOTAL})_{i,t-1} + \text{Firm controls} \\ & + \text{Industry FE} + \text{Country FE} + \text{Year FE} + \varepsilon_{i,t}, \end{aligned} \tag{4}$$

where α and β are the parameters to be estimated and ε is the error term. To control for unobserved heterogeneity across industries, countries and years, the three-way fixed effects are accounted for by introducing dummy variables into the World and European samples while only industry and year fixed effects are required for the US sample. We include two lagged terms of the ROA to control for the potential dynamic effect of profitability on firm value. In addition, we study the potential interaction effects between RD_A and RES. If resource efficiency moderates the beneficial effects of R&D on firm value, we expect a significant and positive coefficient of the interaction term (β_6). The firm control variables include total debts to assets ($LEVERAGE$), dividend yields (DY), net property, plant and equipment to total assets (PPE_A) and log deflated assets ($Ln(Assets)$).

4.4 SAMPLE SELECTION BIAS

We are aware of a potential sample selection bias since we can only include those firms that disclose their resource usage. This choice introduces a possible self-selection bias into our sample that we control for using the Heckman (1979) two-stage procedure. In the first stage, we estimate probit regressions annually using a binary dependent variable, which takes the value one when a firm discloses its resource usage data and zero otherwise, regressed on a number of firm-specific fundamental variables that may explain their choice to disclose. Similar to Cooper et al. (2010), we estimate the probit regressions and calculate the inverse Mills ratio (IMRs) annually, which are then used as explanatory variables in the second-stage firm value regressions specified in Equation (4).

Recognising that firms usually report their resource usage in CSR reports, we draw upon two management theories in the CSR disclosure literature, namely the voluntary disclosure theory and the legitimacy theory, to help us explain a firm's choice of whether to disclose. According to the voluntary disclosure theory, firms are more likely to disclose good news rather than bad news (Bewley and Li, 2000). Since firms with more resource efficiency and lower resource utilisation may face lower future social and environmental costs, resource efficiency may be perceived as good news. Firms with better performance in resource efficiency or even financial performance may therefore disclose more to convey a superiority over competitors. On the other hand, the legitimacy theory views disclosure as a tool to communicate and manage a firm's relation with its stakeholders or society. This may be supplementary to, or in substitution of, actions demanded by stakeholders or society (Patten, 1992; Gray et al., 1995; 1996). The relation between performance and disclosure is then negative when poorer performers have greater need to influence public perception and to manage their image. Although the empirical literature provides no consensus on which theory dominates, it does reveal that firm size and industry effects are important in determining CSR disclosure (Gray et al., 1995; Brammer and Pavelin, 2008; Reverte, 2009). Following this evidence, we include firm size, industry and country fixed effects and a set of firm-specific characteristics to explain a firm's choice to disclose their resource usage. More specifically, these characteristics include year t-1 profitability (ROA), leverage ($LEVERAGE$), asset tangibility (PPE_A), investment (INV_A), research and development expenditure to total assets (RD_A), dividend yield (DY), market capitalisation ($Ln(MCAP)$). We choose this set of fundamental variables because they are widely available and consistent across the World, European and US samples. Also, there are very few missing observations for these variables allowing us to retain as large a sample size as possible. For the World sample, we include all constituent stocks of the MSCI World Index to estimate the IMRs and use these in the second-stage panel regressions for the World and European samples. For the US, we collect data for all stocks listed on the NYSE, NASDAQ and AMEX from CRSP and apply the Heckman procedure in similarly fashion.

4.5 EMPIRICAL RESULTS

The panel regression results are reported in Panels A, B and C of Table 3. The coefficients on the RES in the first column are of most interest and importance to this study as they represent the marginal impact of a firm's resource efficiency on firm value or growth opportunities after controlling for a number of firm-specific characteristics and fixed effects. The estimated coefficients of the constant terms and the firm control variables are not reported for brevity, but are available upon request.

[Insert Table 3 about here]

In the World sample in Panel A, there is strong evidence that RES is positively associated with higher subsequent firm value, which is significant at the 1% level. This significant and positive relationship is robust to controlling for ROA (Row 2), lagged ROA (Row 3), R&D intensity and its interaction with RES (Row 4), capital investment (Row 5) and return volatilities (Row 6). Row 7 reports the estimation with all variables included. In each model, we control for firms' dividend yield, leverage, asset tangibility and size, as well as industry, country and year fixed effects. The significant coefficients on the IMRs show the presence of potential selection bias, but also that it is controlled for, thereby enhancing the robustness of our results. The coefficients on RES range from 0.50 in Row (2) to 0.62 in Row (7) indicating that a one standard deviation increase in RES can be associated with a 2.20% increase in Tobin's Q, which is not only statistically significant at the 1% level, but also economically significant.

Panel B reports the firm value regressions for the European sample. The results are remarkably similar to those for the World sample in that there is a significant and positive relationship between RES and future firm value, robust to firm fundamental characteristics, control variables, fixed effects and selection bias. In Row (7), a one standard deviation increase in RES is associated with a 3.03% increase in Tobin's Q for an average firm in the European sample. Panel C reports the results for the US sample, which are qualitatively similar showing coefficient values on RES that are consistently positive and significantly different from zero at the 1% level in all models and robust to the same control variables. As reported in Row (7), a one standard deviation increase in RES corresponds to a 3.01% increase in Tobin's Q, which is comparable to the World and European samples.

Our regression results demonstrate strong evidence that resource efficiency is positively associated with firm value and that this relationship is robust to the inclusion of fundamental characteristics, unobserved heterogeneity across industries, countries or years, and self-selection bias arising from a firm's decision to disclose resource usage. In addition, our findings are remarkably consistent across the World, European and US samples, showing evidence that this relationship holds for firms across countries as well as industries and fundamental attributes. This evidence is consistent with the abnormal returns earned by MoRE funds in Section 3 and, more importantly, provides corroborative evidence by investigating firm value in firm-level panel regressions with appropriate controls. The significant positive relationship between RES and firm value is perhaps consistent with the many arguments conjectured for the mechanisms underlying the effect, including competitive advantage, intangible assets and other theories for the influence of CSR on value. However, there are important econometric issues to be addressed to ensure that our results are accurate, robust and reliable.

4.6 ENDOGENEITY CONCERNS

We are concerned that the positive relationship between RES and firm value could be endogenous, thus preventing us from obtaining consistent coefficient estimates. Moreover, Equation (4) may be misidentified if causality runs in the opposite direction such that higher firm value may lead firms to invest in resource efficiency, possibly due to more abundant capital (slack resources theory) or access to financing. We adopt three approaches to address this concern. First, in Equation (4) and Table 3, we lag all independent variables by one year to isolate the timing of the impact from the *RES* to firm value in the subsequent year. Although this approach alleviates the potential endogeneity bias, the reverse causality concern remains unresolved (Antonakis et al., 2010), therefore, our second approach estimates two-stage least squares instrumental variable (2SLS IV) regressions. In related work, El Ghoul et al. (2011) and Attig et al. (2013) propose industry-year average CSR measures as instruments, but we opt to use country-year average *RES* (*Country RES*) as our first instrument instead. The first reason for this is that our *RES* is industry-adjusted by construction and thus averaging the *RES* again by industry-year does not provide a suitable instrument. The second and more important justification is that resource efficiency averaged at country level is more likely to be exogenous to Tobin's Q at a firm level because it is likely determined by country-level technological, macroeconomic and cultural factors. Following the method of Attig et al. (2013), we use initial firm-level values of *RES* (*Initial RES*) as a second instrument. To further ensure their exogeneity to firm value, we lag the instruments by one year where possible. Consistent with the regressions reported in Table 3, we include the same firm control variables, fixed effects and IMRs in the 2SLS IV regressions and report the results in Table 4. In the first-stage regressions, the F-statistics of the tests of joint significance on the instruments are considerably higher than the conventional threshold value of 10.0 and the hypotheses are thus rejected indicating that the chosen instruments are relevant. The Hansen tests of over-identification are not rejected in the second-stage regressions, suggesting that these instruments do not have direct impact on firm value and so are exogenous. More importantly, the results confirm the robustness of the positive significant relationship between *RES* and firm value (at 1% level for the World and European samples and at 10% level for the US sample) and indicates that our earlier results are not driven by endogeneity bias.[15]

[Insert Table 4 about here]

Third, we proceed to evaluate the direction of causality by following Luo et al. (2013) in applying tests of Granger-causality (Granger, 1969). The generic approach is expressed as follows:

$$\begin{cases} Y_t &= \sum_{i=1}^{n} a_i Y_{t-i} + \sum_{j=1}^{n} \beta_j X_{t-j} + \varepsilon_t \\ X_t &= \sum_{i=1}^{n} \lambda_i X_{t-i} + \sum_{j=1}^{n} \omega_j Y_{t-j} + \epsilon_t \end{cases}$$

[15]As robustness checks, we use an alternative set of instruments to estimate the 2SLS IV firm value regressions. Specifically, we used the t-3 and t-4 lagged *RES* as instruments. If market is efficient, any underpricing of the value implications of resource efficiency should not persist over time, and hence, these deeply lagged *RES* should not have direct impact on firm value. To evaluate whether the lagged *RES* is exogenous to firm value, we estimate Equation 4 and further included the second (t-2), third (t-3) and fourth (t-4) lagged *RES* as independent variables for the world, European and US samples. The results show consistently that only the t-1 *RES* is significant and positive, suggesting that the deeply lagged *RES* do not have direct impact on firm value. We then estimate the 2SLS IV regressions using the same set of control variables, fixed effects and IMRs as in Equation 4. The first-stage F-statistics are highly significant while the J-statistics of the Hansen tests of instrument validity are insignificant in all three samples. The results of the second-stage regressions are qualitatively similar, and hence, our results of the 2SLS IV regressions are robust to an alternative set of instruments.

where Y_t and X_t are the endogenous variables firm value and RES, respectively, but with RES lagged by one period at the outset. If β_j coefficients are jointly significant, RES Granger-causes firm value, whereas jointly significant ω_j coefficients show that firm value Granger-causes RES. We estimate vector autoregressive models (VAR) with 2 lags for the World, European and US samples with the lag-length selected in accordance with the Schwarz Information Criterion (SIC). Wald tests of joint significance on the lagged coefficients evaluate the direction of causality between year t log Tobin's Q and year t-1 RES.[16] We also include the same firm specific variables as exogenous control variables in the VAR models.

In all three samples, we find strong evidence that year t-1 and t-2 firm values do not Granger-cause year t-1 RES. The p-values of the Wald tests are 0.127, 0.261 and 0.316 for the World, European and US samples, respectively. In contrast, we find that year t-2 and t-3 RES Granger-cause year t firm value with p-values of 0.018, 0.023 and 0.078 for the World, European and US samples, respectively, consistent with our previous results that RES predicts future firm values. These results indicate that the firm value regressions of Equation 4 are not biased by reverse causality since the evidence shows that causality goes from RES to subsequent firm value. All of our identification strategies add support and robustness to our main finding that a higher RES is associated with higher subsequent firm value.

5 ROBUSTNESS TESTS

While the positive and significant association between RES and future firm value is an insightful discovery, the following sections provide a deeper exploration of the robustness of the result. Specifically, we investigate whether the RES-firm value relationship remains consistent when we control for three sets of other variables. We choose these additional controls so that our methods enhance the importance of RES even in the presence of other value generating factors such as corporate governance, CSP or information uncertainty. Since Table 2 shows that there is very little correlation between RES and these additional controls, there is little evidence to suggest that RES is acting as a proxy for these other factors, however, this section tests this possibility more forcefully. The data for these additional control variables are only available for the US sample, so we are limited to analysing US firms in this section. By adding these further controls and documenting consistent, positive and significant coefficients, the results show that the relationship between RES and firm value is robust.

[16]More specifically, we evaluate whether reverse causality is present between the year t firm value and year t-1 RES based on the specification in Equation 4. Hence, when we run the causality analysis, the endogenous variables included are the year t log Tobin's Q and the year t-1 RES, instead of their contemporaneous values.

5.1 CORPORATE GOVERNANCE

There is an enormous literature demonstrating the effect of corporate governance on firm value. We include a number of variables in the regressions and test whether the positive RES-firm value relationship remains robust. An alternative interpretation could be that RES is a proxy for the quality of management and governance. If this is the case (even though the correlations suggest it is not), the inclusion of many important governance variables should detect the value relevant relationships and diminish the impact of RES. We first consider a number of variables relating to CEO characteristics, including CEO age, tenure, gender, total compensation, ownership and duality. CEO tenure is the number of years the CEO has been in the current position and is expected to be positively related to firm value (Luo et al., 2013). CEO gender is a dummy variable that proxies for management diversity and equals one when the CEO is female. Executive compensation is an important determinant of firm value and is viewed as a proxy for agency costs (Core et al., 1999). CEO ownership is the percentage of stock owned by the CEO and is expected to be positively related to firm value (Mehran, 1995). CEO duality is a proxy for CEO power in the board and is a dummy variable taking the value one when the CEO is also the Chairman of the Board of Directors.

A second category of corporate governance relates to board characteristics that include board age, tenure, gender, size, independence and ownership and may determine future firm performance. Board age and tenure are the average age and years in position of independent directors in a given year. Board size is the total number of board members and is expected to be negatively related to firm value as smaller boards of directors are more effective in monitoring management (Yermack, 1996). Board gender proxies for board diversity and is calculated as the proportion of independent directors that are female in a given year. This is expected to be positively related to firm value and may increase board independence and activism by having directors with diverse background, culture and education (Carter et al., 2003). We measure board independence as the ratio of independent directors to the total number of board directors and this is expected to improve the effectiveness of board monitoring of managerial performance and hence firm value. Stulz (1988), Morck et al. (1988) and McConnell and Servaes (1990) document a positive but non-linear relation between board ownership and firm value. To control for this we include the average percentage of independent directors' stock ownership.

5.2 CORPORATE SOCIAL PERFORMANCE

There is also an extensive literature that studies the implications of a firm's CSP on its financial performance. Whilst there is a lot of mixed evidence presented, the meta analysis by Orlitzky et al. (2003)

shows that there is a positive relationship between CSP and firm performance. In addition, a recent literature review by van Beurden and Gössling (2008) argues that most of the studies document a positive correlation between a firm's corporate social and financial performance while opposing studies are criticised based on their use of measures and methods that are no longer applicable. In the context of CSP, resource efficiency may impact on firm value in two indirect ways. First, although RES presents a direct measure of how effective a firm is in managing resources, firms with high resource efficiency may also tend to be those with similar high achievement in other CSP characteristics. In our analysis, RES may therefore simply be a proxy for high general CSP. Second, the RES may be a mechanism for resource efficient firms to voluntarily disclose their superior CSP over their competitors. We use KLD ratings that have been applied widely in the literature to control for four dimensions of CSP. Following Kempf and Osthoff (2007) and Galema et al. (2008), the ratings for each dimension are computed as the total number of strengths minus the total number of concerns.

The first dimension is a firm's performance in product innovation. A firm's strength in this dimension relates positively to its product quality, leadership in R&D within the industry, product provision to the economically disadvantaged and social benefits while its concern may come from controversies in product quality, marketing, contracting, antitrust violations and franchises. The second dimension is a firm's relations with its employees in which its strengths include fairness to unionised workforce, favorable policies to employees, retirement benefits, health and safety programmes and other employee relation initiatives. The concerns are poor union relations, controversies in health and safety and retirement benefits and workforce reduction. Luo et al. (2013) show that both product and employee relations dimensions explain firms' abnormal returns. Edmans (2011) shows that firms with high level of employee satisfaction generate long-term abnormal returns and concludes that market does not fully value intangibles. The third dimension is diversity which is evaluated on management or human resource policies on diversity in gender, ethnicity, minorities, disability and sexuality. Galema et al. (2008) find that a firm's diversity affects stock returns by lowering its book-to-market ratios as shown by portfolios sorted on KLD ratings. The fourth dimension is a firm's relations with its community. The strength indicators are related to charitable and innovative giving, support for education and housing and its relations with indigenous peoples while the concern indicators are generated by controversies in financing and lending, negative economic impacts on the community, and tax disputes.

5.3 INFORMATION UNCERTAINTY

Managers respond to the perceptions of society's expectations by adopting specific disclosure strategies (Patten, 1992; Milne and Patten, 2002). Both theoretical and empirical evidence suggest that CSP is an important factor in determining a firm's level and quality of CSR disclosure (see e.g. Belkaoui and Karpik, 1989; Patten, 1992; Hughes et al., 2001;). Voluntary disclosure theory suggests that firms with better CSP will make better discretionary disclosure in both quantity and quality (Clarkson et al., 2008), while legitimacy theory suggests that worse CSP is associated with better disclosure as firms attempt to legitimise their poor performance. Alternatively, CSR is also linked to information asymmetry. Dhaliwal et al. (2011) find that CSR disclosure among firms with good prior CSP attracts analyst coverage who exhibit lower forecast errors and dispersion. Similarly, Dhaliwal et al. (2012) document evidence that CSR disclosure is inversely related to analysts' forecast errors. This evidence suggests that CSP and CSR disclosure are closely related to subsequent information uncertainty. A firm with better performance in resource efficiency will likely have higher quality CSR disclosure, which may generate more analyst coverage and lower information uncertainty. In relation to firm value, Chen and Steiner (2000) show that analyst coverage is a positive influence. Jo and Harjoto (2011) find that analyst coverage has positive impact on firm value for firms with CSR engagement. In sum, resource efficiency, as one possible dimension of a firm's CSP, could impact upon firm value through its indirect effect via analyst coverage or information uncertainty. To control for these effects, we include analyst coverage and forecast dispersion as control variables. Analyst coverage is measured by the average monthly number of analyst forecasts over a fiscal year while dispersion is the average monthly forecast standard deviation scaled by its fiscal year-end closing stock price. Both variables are log transformed by taking log of one plus the variable.

5.4 EMPIRICAL RESULTS

The empirical results of the firm value regressions, which control for the corporate governance, CSP and investment uncertainty factors, are reported in Table 5. Similar to Equation 4, we include in each model firm-specific control variables and industry and year fixed effects, whilst robust standard errors are clustered at the firm level.

[Insert Table 5 about here]

The key result throughout Table 5 is that *RES* retains its significant positive relationship with firm value no matter which controls are included, albeit with smaller coefficient values compared to Table 3.

In Column (1), after controlling for CEO age, tenure and gender characteristics, the positive relationship between RES and subsequent firm value remains highly significant (at 1% level). Column (2) adds CEO pay, ownership and duality and the positive coefficient on RES increases slightly and remains significant at 5% level. Controlling for the board characteristics of board age, tenure, gender and size in Column (3), the positive and significant coefficient on RES remains robust. And in Column (4), board independence and ownership are included as controls and the coefficient on RES becomes slightly smaller while remaining statistically significant at the 10% level.

Controlling for CSP not related to environmental factors, we include the four KLD dimensions in Column (5). The positive coefficient on RES decreases but remains significant at the 5% level. This shows that RES plays a robust role in predicting subsequent firm value even when controlling for other categories of CSP. This suggests that RES generates specific value in addition to generic social responsibility. In Column (6) we include the log analyst coverage and forecast dispersion variables. After controlling for the firm's information uncertainty, RES still impacts positively on future firm value with the effect significant at the 5% level. Finally, we control for all factors simultaneously, but due to the large number of explanatory and control variables, we estimate a stepwise regression with backward selection at a significance level of 0.2 to determine the appropriate specification which only retains significant explanatory variables.[17] The results reported in Column (7) show that the coefficient on RES is again positive and significant at the 1% level, lending robust support to the view that the positive impact of RES on firm value cannot be diminished when controlling for these other value generating factors.

6 RESOURCE EFFICIENCY AND CREDIT RATINGS

Whilst the majority of empirical studies on CSR issues investigate accounting performance and shareholder value, other researchers have turned their attention to risk, risk premia and firms' cost of capital. For equity financing, El Ghoul et al. (2011) find that firms with better CSP enjoy lower cost of equity, and more pertinent to this study, Chava (2011) shows that firms with environmental concerns generate higher risk premia and implied cost of equity. For debt financing, Menz (2010) suggests that CSR may have a larger impact in credit markets than equity as lenders and creditors are more concerned about social issues and their associated risks compared to equity investors and documents weak evidence that higher CSP delivers lower credit spreads. Attig et al. (2013) argue that credit rating agencies study both financial and non-financial information to evaluate a firm's creditworthiness and find that firm CSP

[17] For the stepwise regression reported in Column (7), we excluded the CEO and board ownership variables as including them reduce the sample size substantially. When we included the ownership variables, the relationship between RES and firm value remained positive and significant at the 10% level.

improves credit ratings resulting in lower cost of debt. In more specific studies, Bauer et al. (2009) and Verwijmeren and Derwall (2010) investigate employee relations and employee well being, showing that firms with better performance in employment characteristics enjoy lower cost of debt, higher credit ratings, lower bankruptcy risk and lower debt ratios. Focusing on environmental issues, Bauer and Hann (2010) report higher cost of debt and lower credit rating for firms with more environmental concerns and lower cost of debt when they proactively engage in environmental practices. Building on this evidence, we argue that a firm's resource efficiency is able to increase credit ratings and lower debt costs. Efficiency in the use of resources is value generating in demonstrating control of costs, revenue generation and competitive advantage, which should reduce risk. The disclosure of such information also provides non-financial information, which could reduce information uncertainty with the information acting as a proxy for efficiency in areas other than the use of resources.

We collect credit ratings data compiled by Standard & Poor's from Bloomberg. Merging these with our other data, our sample consists of 218, 78 and 112 firms in the World, European and US samples. Following Ashbaugh-Skaife et al. (2006), we construct an ordinal, ranking credit rating variable by assigning the number one to rating levels of CCC+ or below, two to B-, B and B+, three to BB-, BB and BB+, four to BBB-, BBB and BBB+, five to A-, A and A+, six to AA-, AA, and AA+ and seven for AAA. This credit rating variable is to be used as the dependent variable. Panel A of Table 6 reports the distribution of the credit rating data. The World and European samples show the largest number of observations in the BBB+ rating class while for US firms, the largest number of observations falls into the A rating.

[Insert Table 6 about here]

We begin with an univariate comparison of year t-1 RES across two groups of firms and report the results of the two-sample t-tests in Panel B. The first group have ratings of BBB+ or lower (below investment grade) while the second group have ratings that are higher than BBB+ (investment grade). In the World sample, the average RES is -0.030 among firms with ratings of BBB+ or below and 0.045 for firms with higher than BBB+ ratings. The difference is 0.075 and is statistically significant at the 1% level. The difference in mean RES is even more pronounced for the European sample with mean RES 0.158 higher in the higher rating group, significant at the 1% level. The mean difference in the US sample is smaller at 0.024, which is significant at the 5% level.

We proceed to a multivariate analysis which allows us to control for other firm-specific fundamental variables, industry, country and year fixed effects as well as potential selection bias. Following Ashbaugh-Skaife et al. (2006), we estimate ordered logit regressions because we cannot assume uniform effects of moving across the seven categories of the rating variable. Firm control variables and fixed effects are the same as those in Equation 4 and robust standard errors are clustered at the firm level.

In Columns (1) and (2) of Panel C, the coefficients on RES are positive and significant at the 1% level in the World and European samples, indicating a strong and positive marginal impact of RES on credit ratings. The results show that resource efficiency is significantly associated with higher credit ratings, supporting the view that resource efficient firms have lower costs of debt than less efficient firms. This explains why RES is positively correlated with leverage in the pairwise correlations of Table 2 as more resource efficient firms with higher credit ratings have a higher propensity to issue debts at lower relative cost. In Column (3), however, despite a positive coefficient, RES is insignificant in explaining credit ratings among the US firms. The finding warrants further attention in future research as it may relate to the lower priority of resource efficiency in US firms, or properties of the distribution and dynamics of credit ratings across countries.

We perform a number of robustness checks to verify our results. We first re-estimate the rating results using pooled OLS regressions with standard errors clustered at the firm- level. The untabulated results are qualitatively similar and show that RES is significantly positively associated with credit ratings in the World and European samples.[18] Second, we test the robustness of our results to endogeneity and reverse causality using two approaches, which are similar to our methods in estimating Equation 4. Following Attig et al. (2013), we estimate the ordered logit regressions using the three-year lagged RES and find consistent results. We then estimate 2SLS IV regressions using the country-average RES and the initial firm-level RES as instruments and report these results in Table 7. In Columns (1) to (3), the F-statistics of the first-stage regressions are highly significant in all three samples indicating that the instruments are relevant for explaining RES. In the second-stage regressions, represented in Columns (4) to (6), the J-statistics of the Hansen tests for over-identification are insignificant. This indicates that the instruments satisfy the exclusion criteria. Reinforced by this support for the identification and of primary concern to this study, the coefficients on RES remain consistently positive and highly significant in the World and European samples and positive but insignificant for the US. The consistency of this result across specifications confirms that our results are not likely driven by endogeneity bias. Finally, we also use an alternative and finer categorisation for the credit rating variables in which each individual rating is assigned its own numeric value ranging from one (CCC+ and below) to seventeen (AAA). We replicate our univariate and multivariate analysis using this alternative rating variable and our main conclusion is unaffected.

[18]The results of these regressions are of course available upon request.

[Insert Table 7 about here]

7 CONCLUSIONS

There is a vast and long history of literature on CSR and its importance for firm strategy and influence on firm value and performance. This comprises theory on the motivations and benefits of CSR, empirical tests on the relationship between CSR events and firms' performance across CSR dimensions on accounting performance, share prices and firm value, and performance evaluation of portfolios and mutual funds constructed using CSR criteria. Instrumental stakeholder theory and the resource based view of the firm suggest a positive link between CSR and firm value and performance. Similarly, the inability of markets to recognize and efficiently price the intangible nature of CSR benefits also suggests that firms with high CSP may be undervalued, delivering returns to investors and value to shareholders over time as the market adjusts. These arguments are supported by the empirical tests using cross-sectional data or stock portfolios. However, this confirmatory empirical evidence is tempered by potential statistical and econometric biases in cross-sectional tests and the reliance on hypothetical stock portfolios rather than accessible investment products.

More recently, concerns have been raised about the effectiveness of CSR in delivering social value. Via the resource based view of the firm, firms may be able to achieve shared value, that is, innovation and entrepreneurship in sustainability ventures that benefit society that create competitive advantages ultimately delivering economic value. We test this possibility using an innovative measure of resource efficiency supplied by Osmosis Investment Management that measures environmental performance, but may also proxy for the beneficial resources and characteristics of firms and managers that the theories advocate. The international firm-level metric is objective and numeric and so avoids certain measurement errors and in cross sectional tests we are careful to control for other econometric biases. Our results show that more resource efficient firms earn higher investment returns in portfolio performance analysis. Consistent across specifications and robust to the inclusion of other value generating variables, higher RES also delivers firm value. Resource efficient firms are also more creditworthy. Using this innovative and proprietary RES, our results confirm the most recent studies that sustainability is associated with firm value suggesting tentative evidence that shared value can be achieved.

Before extolling the virtues of the shared value theory more forcefully, we look forward to examining more thoroughly the mechanisms through which RES affects firm value. Although we control for managerial and governance characteristics, other CSP measures and information uncertainty in robustness tests, it would be instructive to investigate more formally whether sustainability via RES is indeed linked to the resources and capabilities such innovativeness, entrepreneurship, image, reputation, brand that the resource based view of the firm suggests. Similarly, deeper investigation of the influences of resource efficiency on the value chain would be required to lend support to the shared value theory. From an investment and finance context, we look forward to extending our understanding of resource efficiency beyond material cost savings to investigate the concept of economic value added.

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Table 1: Analysis of MoRE funds

Model	US (1)	UK (2)	Japan (3)	Europe (4)	World (5)
Panel A: CAPM					
α	0.004*	0.005**	0.002	0.004**	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
β_{MKT}	1.198***	0.920***	0.893***	1.129***	1.085***
	(0.059)	(0.056)	(0.050)	(0.068)	(0.040)
Obs	108	96	108	108	108
R^2	0.858	0.790	0.911	0.861	0.929
Panel B: FF-3 model					
α	0.003**	0.004***	0.003*	0.004**	0.006***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
β_{MKT}	1.084***	0.960***	0.912***	1.073***	1.078***
	(0.043)	(0.038)	(0.047)	(0.054)	(0.040)
β_{SMB}	0.380***	0.380***	0.117**	0.409***	0.289***
	(0.099)	(0.046)	(0.059)	(0.087)	(0.089)
β_{HML}	0.209*	−0.127*	−0.111	0.274***	−0.029
	(0.109)	(0.071)	(0.078)	(0.070)	(0.101)
Obs	108	96	108	108	108
R^2	0.889	0.882	0.917	0.902	0.935
Panel C: C-4 model					
α	0.004**	0.005***	0.003**	0.006**	0.007***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
β_{MKT}	1.039***	0.980***	0.907***	1.050***	1.058***
	(0.036)	(0.038)	(0.044)	(0.042)	(0.036)
β_{SMB}	0.368***	0.330***	0.151***	0.376***	0.279***
	(0.069)	(0.052)	(0.053)	(0.073)	(0.080)
β_{HML}	0.096	−0.212**	−0.095	0.116	−0.135
	(0.086)	(0.082)	(0.068)	(0.076)	(0.095)
β_{WML}	−0.188***	−0.096**	−0.095*	−0.186***	−0.150***
	(0.043)	(0.045)	(0.050)	(0.041)	(0.036)
Obs	108	96	108	108	108
R^2	0.915	0.889	0.921	0.922	0.945

This table reports the results of the monthly time series regressions of the CAPM model (Panel A), the Fama and French (1993) three-factor model (FF-3, Panel B) and the Carhart (1997) four-factor model (C-4, Panel C). Columns (1) to (4) refer to the tests on the US, UK, Japanese and European MoRE replicating portfolios and Column (5) reports the results for the accessible Osmosis MoRE World fund. All MoRE portfolio and the World fund returns are provided by Osmosis Investment Management. For the Osmosis MoRE World Fund, any monthly returns before August 2011 are based on back-testing simulation results while all other portfolios are based on back-testing results and are not traded. The S&P 500, FTSE 100, MSCI Japan, MSCI Europe and MSCI World indices are used as proxies for the US, UK, Japanese, European and global market portfolios. The US, Japanese, European and Global size (SMB), value (HML) and momentum (WML) factors and their respective risk-free rates are downloaded from Kenneth French's data library while those of the UK markets are downloaded from the data web site of Gregory et al. (2013). The sample period is from January 2005 to December 2013 except for UK as the UK pricing factors are available up to December 2012 only. The estimated coefficients, standard errors and R^2 are reported. '*', '**' and '***' denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 2: Summary statistics

Panel A: Summary statistics

World sample

Variable	Obs	Mean	Stdev	25^{th}	50^{th}	75^{th}	Correlations: Ln(Tobin's Q)	Correlations: RES
RES	3,917	0.034	0.344	−0.017	0.038	0.111	0.037**	1.000
ROA	3,903	0.136	0.080	0.091	0.127	0.176	0.477***	−0.003
RD_A	3,917	0.034	0.040	0.004	0.021	0.045	0.249***	−0.023
INV_A	3,915	0.050	0.035	0.026	0.041	0.064	−0.058***	0.020
σ^{TOTAL}	3,911	0.090	0.050	0.058	0.078	0.109	−0.142***	−0.050***
$Ln(\sigma^{TOTAL})$	3,911	0.085	0.044	0.056	0.075	0.103	−0.144***	−0.049***
LEVERAGE	3,917	0.557	0.179	0.444	0.572	0.684	−0.172***	0.047**
PPE_A	3,917	0.298	0.193	0.150	0.254	0.393	−0.235***	0.031*
DY	3,908	0.022	0.017	0.010	0.019	0.031	−0.120***	0.072***
Tobin's Q	3,914	1.576	0.905	1.034	1.303	1.810	0.966***	0.024
Ln(Tobin's Q)	3,914	0.904	0.273	0.710	0.834	1.033	1.000	0.037**
Assets	3,917	27,885	43,900	4,715	11,348	29,417	−0.150***	0.064***
Ln(Assets)	3,917	9.407	1.290	8.458	9.339	10.284	−0.215***	0.029*
MCAP	3,917	21,923	35,595	3,302	8,404	21,761	0.241***	0.037**
Ln(MCAP)	3,917	9.093	1.361	8.102	9.036	9.988	0.295***	0.039**

European sample

Variable	Obs	Mean	Stdev	25^{th}	50^{th}	75^{th}	Correlations: Ln(Tobin's Q)	Correlations: RES
RES	1,385	0.053	0.329	−0.008	0.047	0.133	0.022	1.000
ROA	1,384	0.140	0.079	0.093	0.128	0.179	0.434***	−0.009
RD_A	1,385	0.028	0.038	0.002	0.016	0.033	0.215***	−0.046*
INV_A	1,383	0.048	0.032	0.027	0.040	0.061	−0.062**	0.040
σ^{TOTAL}	1,385	0.094	0.050	0.060	0.081	0.113	−0.195***	−0.030
$Ln(\sigma^{TOTAL})$	1,385	0.089	0.044	0.058	0.078	0.107	−0.199***	−0.029
LEVERAGE	1,385	0.597	0.151	0.505	0.605	0.702	−0.219***	0.079***
PPE_A	1,385	0.278	0.185	0.137	0.231	0.371	−0.208***	0.131***
DY	1,382	0.030	0.019	0.017	0.027	0.040	−0.142***	0.171***
Tobin's Q	1,385	1.585	0.964	1.060	1.319	1.796	0.959***	0.008
Ln(Tobin's Q)	1,385	0.905	0.275	0.723	0.841	1.028	1.000	0.022
Assets	1,385	34,259	50,944	4,306	11,917	39,048	−0.236***	0.101***
Ln(Assets)	1,385	9.485	1.456	8.397	9.397	10.585	−0.318***	0.075***
MCAP	1,385	23,498	35,308	3,153	8,421	26,757	0.169***	0.075***
Ln(MCAP)	1,385	9.106	1.455	8.056	9.038	10.195	0.143***	0.083***

US Sample

Variable	Obs	Mean	Stdev	25^{th}	50^{th}	75^{th}	Correlations: Ln(Tobin's Q)	Correlations: RES
RES	1,108	0.029	0.124	−0.013	0.025	0.073	0.085***	1.000
ROA	1,108	0.071	0.092	0.043	0.074	0.109	0.491***	0.045
RD_A	1,108	0.045	0.053	0.008	0.024	0.066	0.304***	0.010
INV_A	1,108	0.044	0.034	0.021	0.034	0.056	0.126***	−0.059*
σ^{TOTAL}	1,107	0.091	0.058	0.054	0.077	0.110	−0.277***	−0.037
$Ln(\sigma^{TOTAL})$	1,107	0.085	0.049	0.053	0.074	0.104	−0.277***	−0.037
LEVERAGE	1,108	0.212	0.143	0.113	0.199	0.292	−0.327***	−0.057*
PPE_A	1,108	0.234	0.162	0.106	0.189	0.308	−0.124***	−0.170***
DY	1,108	0.017	0.021	0.000	0.014	0.025	−0.177***	0.017
Tobin's Q	1,108	2.061	1.081	1.353	1.742	2.454	0.970***	0.066**
Ln(Tobin's Q)	1,108	1.071	0.292	0.856	1.009	1.240	1.000	0.085***
Assets	1,108	30,075	56,440	4,773	11,137	29,578	−0.159***	0.088***
Ln(Assets)	1,108	9.416	1.296	8.471	9.318	10.295	−0.195***	0.009
MCAP	1,108	30,722	39,343	5,181	13,952	37,112	0.166***	0.050*
Ln(MCAP)	1,108	9.554	1.314	8.553	9.543	10.522	0.296***	0.051*
CEO_Age	1,021	55.154	5.881	51	55	59	−0.060*	0.030
CEO_Tenure	1,030	5.221	5.053	2	4	7	0.096***	0.021
CEO_Gender	1,031	0.041	0.198	0	0	0	0.013	0.050
CEO_Compensation	1,029	0.001	0.001	0.000	0.001	0.001	0.301***	−0.008
CEO_Ownership	295	1.827	4.084	0.274	0.611	1.300	0.207***	0.011
CEO_Duality	1,031	0.634	0.482	0	1	1	−0.102***	−0.008
Board_Age	678	55.154	3.012	60.571	62.545	64.625	−0.044	0.007
Board_Tenure	937	7.544	2.394	6.000	7.600	9.000	0.044	0.089***
Board_Gender	937	0.190	0.102	0.125	0.200	0.250	0.011	0.069**
Board_Size	937	10.822	1.939	9.000	11.000	12.000	−0.132***	−0.009
Board_Independence	937	0.811	0.102	0.750	0.833	0.900	−0.161***	−0.011
Director_Ownership	364	0.567	2.048	0.000	0.000	0.000	0.082	−0.041
Product	876	−0.558	1.150	−1.000	0.000	0.000	0.108***	0.040
Employee	876	0.095	1.463	−1.000	0.000	1.000	0.267***	0.045
Diversity	876	1.882	1.784	0.000	2.000	3.000	0.123***	0.050
Community	876	0.470	0.998	0.000	0.000	1.000	0.122***	0.051
Analyst_Coverage	1049	16.323	7.032	11.091	15.917	20.833	0.193***	0.037
Ln(Analyst_Coverage)	1049	2.754	0.476	2.492	2.828	3.083	0.161***	0.008
Analyst_Disp	1049	0.295%	0.480%	0.071%	0.136%	0.316%	−0.411***	−0.062**
Ln(Analyst_Disp)	1049	0.293%	0.473%	0.071%	0.136%	0.316%	−0.413***	−0.062**

Table 2: Summary statistics (Con't)

Panel B: Country distribution										
Country	2005	2006	2007	2008	2009	2010	2011	2012	Total	%
Austria	2	2	2	2	2	2	2	0	14	0.36
Belgium	6	6	6	5	6	6	6	1	42	1.07
Brazil	0	1	1	1	1	1	1	0	6	0.15
Canada	4	4	5	6	7	8	15	6	55	1.40
Denmark	6	6	6	6	6	5	6	4	45	1.15
Finland	9	12	12	11	13	13	13	8	91	2.32
France	22	27	28	26	23	24	24	6	180	4.60
Germany	26	27	28	29	28	27	29	5	199	5.08
Hong Kong	1	1	2	2	2	2	2	0	12	0.31
India	1	1	1	1	1	1	1	0	7	0.18
Italy	10	9	10	8	8	7	7	0	59	1.51
Japan	146	149	152	154	153	152	150	9	1065	27.19
Netherlands	8	8	8	9	9	9	9	5	65	1.66
Norway	5	7	7	6	5	6	6	2	44	1.12
Portugal	0	0	0	0	0	0	1	1	2	0.05
South Africa	0	0	0	0	0	0	0	1	1	0.03
Spain	6	3	3	2	3	3	2	0	22	0.56
Sweden	15	17	17	18	17	17	17	11	129	3.29
Switzerland	17	19	20	19	18	19	19	4	135	3.45
Taiwan	2	2	2	2	2	2	2	0	14	0.36
UK	53	54	55	49	44	45	45	13	358	9.14
US (Datastream)	172	178	178	180	186	184	180	114	1372	35.03
Total: Full sample	511	533	543	536	534	533	537	190	3917	100.00
Total: European	185	197	202	190	182	183	186	60	1385	35.36
Total: US (Compustat)	152	156	159	159	163	160	159	0	1108	28.29

Table 2: Summary statistics (Con't)

Panel C: Year distribution by industry sectors										
Industry	2005	2006	2007	2008	2009	2010	2011	2012	Total	%
Aerospace & Defense	18	19	18	17	17	17	17	9	132	3.37
Altertive Energy	2	2	2	3	3	3	2	1	18	0.46
Automobiles & Parts	28	28	30	30	29	28	29	5	207	5.28
Beverages	8	9	9	9	12	12	14	7	80	2.04
Chemicals	48	52	53	51	50	50	51	11	366	9.34
Construction & Materials	19	19	21	21	20	20	20	3	143	3.65
Electricity	19	20	19	20	23	22	21	3	147	3.75
Electronic & Electrical Equipment	22	23	23	23	24	23	25	6	169	4.31
Fixed Line Telecommunications	8	6	8	6	6	7	7	3	51	1.30
Food & Drug Retailers	6	6	6	6	5	7	6	4	46	1.17
Food Producers	20	20	19	20	19	20	20	10	148	3.78
Forestry & Paper	5	6	7	5	5	5	5	3	41	1.05
Gas, Water & Multi-utilities	14	15	15	14	11	12	11	0	92	2.35
General Industrials	18	19	19	19	18	18	18	10	139	3.55
General Retailers	11	11	12	11	12	10	8	2	77	1.97
Health Care Equipment & Services	12	12	13	14	14	14	14	6	99	2.53
Household Goods & Home Construction	12	14	13	12	13	13	14	7	98	2.50
Industrial Engineering	36	40	39	41	40	41	43	14	294	7.51
Industrial Metals & Mining	15	16	17	17	17	18	17	5	122	3.11
Industrial Transportation	7	7	7	7	7	6	7	1	49	1.25
Leisure Goods	8	8	8	8	8	8	8	1	57	1.46
Mining	4	4	5	6	6	7	6	1	39	1.00
Mobile Telecommunications	5	5	5	5	5	6	6	0	37	0.94
Oil & Gas Producers	17	20	21	21	18	18	23	12	150	3.83
Oil Equipment & Services	11	11	9	10	11	11	11	5	79	2.02
Persol Goods	15	16	18	17	16	17	15	8	122	3.11
Pharmaceutical & Biotechnology	36	37	38	36	38	36	36	14	271	6.92
Software & Computer Services	15	14	15	15	15	15	14	7	110	2.81
Support Services	11	12	13	11	11	8	9	4	79	2.02
Technology Hardware & Equipment	53	54	52	52	52	51	51	24	389	9.93
Tobacco	4	4	4	4	4	4	3	1	28	0.71
Travel & Leisure	4	4	5	5	5	6	6	3	38	0.97
Total	511	533	543	536	534	533	537	190	3917	100.00

Table 2: Summary statistics (Con't)

Panel D: Average RES over time, grouped by countries

Country	2005	2006	2007	2008	2009	2010	2011	2012	Grand mean
Austria	0.071	0.112	0.116	0.044	0.080	0.097	0.083	-	0.086
Belgium	−0.118	−0.029	0.012	−0.070	−0.052	−0.031	−0.034	0.368	0.006
Brazil	-	−0.071	−0.057	0.014	0.000	0.027	0.032	-	−0.009
Canada	0.203	0.157	−0.312	−0.342	−0.575	−0.786	−0.283	0.123	−0.227
Denmark	−0.057	−0.134	−0.099	−0.071	−0.070	−0.021	−0.009	−0.058	−0.065
Finland	0.152	0.068	0.147	0.106	0.121	0.117	0.134	0.069	0.114
France	−0.037	−0.041	0.030	0.054	0.092	0.085	0.088	0.044	0.039
Germany	0.004	0.013	0.030	0.037	0.048	0.052	0.039	0.018	0.030
Hong Kong	-	0.056	−0.331	0.098	0.116	0.074	0.137	0.075	0.032
India	-	0.014	−0.015	−0.119	−0.067	−0.075	−0.047	−0.043	−0.050
Italy	0.220	0.056	0.028	0.175	0.170	0.203	0.179	-	0.147
Japan	−0.044	0.055	0.039	0.053	0.028	0.014	0.020	−0.001	0.021
Netherlands	−0.046	−0.258	0.059	−0.071	−0.098	−0.168	0.002	0.030	−0.069
Norway	−0.004	−0.069	0.063	−0.218	−0.095	−0.156	−0.075	0.197	−0.044
Portugal	-	-	-	-	-	-	0.043	0.111	0.077
South Africa	-	-	-	-	-	-	-	−1.723	−1.723
Spain	0.159	0.202	0.309	0.272	0.215	0.176	0.286	-	0.231
Sweden	−0.021	−0.091	0.099	0.108	0.109	0.130	0.151	0.066	0.069
Switzerland	0.001	−0.015	0.044	0.026	0.040	0.037	0.027	−0.012	0.019
Taiwan	−0.018	−0.205	−0.178	−0.176	−0.181	−0.306	−0.141	-	−0.172
UK	0.022	0.022	0.114	0.133	0.098	0.113	0.133	0.191	0.103
US	0.030	0.029	0.028	0.028	0.024	0.034	0.034	-	0.029
European Sample	0.018	−0.014	0.070	0.063	0.066	0.067	0.083	0.096	0.056

This table reports the summary statistics, year distribution, industry distribution and average *RES* grouped by countries and years, respectively. In Panel A, we report the number of observations, means, standard deviations, the quartile statistics and the pairwise correlations between the variables with firm value and *RES*. The world, European and US samples are reported in separate panels. We report the pairwise correlations between a variable and the year t log Tobin's Q ($Ln(Tobin's\ Q)$) as well as between a variable and its year t-1 *RES*. Statistical significance of the 10%, 5% and 1% levels of the pairwise correlations are denoted by '*', '**' and '***' respectively. Panel B reports the number of firm observations grouped by countries and years. The second last column to the right is the total number of observations of a given country and the last column reports its percentage proportion in the sample. Panel C reports the number of firm observations grouped by industry and years of our world sample. The industries are defined following the Industry Classification Benchmark (ICB) classification. The second last column to the right is the total number of observations of a given industry and the last column reports its percentage proportion in the sample. Panel D reports the mean *RES* of each country in each year. The last column to the right reports the mean *RES* across years of a given country.

Table 3: Firm value regressions

Panel A: World sample

											Fixed effects				
Variables	RES	ROA	$ROA(-1)$	$ROA(-2)$	RD_A	$(RES \times RD\_A)$	INV_A	$Ln(\sigma^{TOTAL})$	IMR	$Controls$	$Industry$	$Country$	$Year$	Obs	R^2
(1)	0.056***								−0.540***	Y	Y	Y	Y	3,858	0.562
	(0.011)								(0.048)						
(2)	0.050***	1.009***							−0.462***	Y	Y	Y	Y	3,858	0.623
	(0.010)	(0.089)							(0.035)						
(3)	0.057***	0.496***	0.374***	0.391***					−0.404***	Y	Y	Y	Y	2,599	0.675
	(0.011)	(0.064)	(0.056)	(0.056)					(0.032)						
(4)	0.050***				0.328	0.493			−0.529***	Y	Y	Y	Y	3,858	0.563
	(0.013)				(0.291)	(0.710)			(0.050)						
(5)	0.050***						0.955***		−0.540***	Y	Y	Y	Y	3,858	0.569
	(0.012)						(0.195)		(0.049)						
(6)	0.054***							−0.305**	−0.530***	Y	Y	Y	Y	3,858	0.563
	(0.011)							(0.152)	(0.049)						
(7)	0.062***	0.499***	0.367***	0.390***	0.291	−0.634	0.083	−0.115	−0.393***	Y	Y	Y	Y	2,599	0.676
	(0.015)	(0.062)	(0.057)	(0.056)	(0.239)	(0.697)	(0.169)	(0.123)	(0.033)						

Panel B: European sample

											Fixed effects				
Variables	RES	ROA	$ROA(-1)$	$ROA(-2)$	RD_A	$(RES \times RD\_A)$	INV_A	$Ln(\sigma^{TOTAL})$	IMR	$Controls$	$Industry$	$Country$	$Year$	Obs	R^2
(1)	0.062***								−0.636***	Y	Y	Y	Y	1,377	0.571
	(0.019)								(0.059)						
(2)	0.054***	1.030***							−0.553***	Y	Y	Y	Y	1,377	0.619
	(0.018)	(0.148)							(0.062)						
(3)	0.082***	0.539***	0.482***	0.259**					−0.505***	Y	Y	Y	Y	910	0.679
	(0.022)	(0.132)	(0.096)	(0.116)					(0.062)						
(4)	0.054***				0.140	0.829			−0.631***	Y	Y	Y	Y	1,377	0.571
	(0.021)				(0.565)	(1.577)			(0.062)						
(5)	0.061***						0.975***		−0.638***	Y	Y	Y	Y	1,377	0.575
	(0.019)						(0.317)		(0.058)						
(6)	0.056***							−0.815***	−0.610***	Y	Y	Y	Y	1,377	0.577
	(0.019)							(0.193)	(0.061)						
(7)	0.088***	0.501***	0.478***	0.249**	−0.159	−0.896	0.406	−0.487**	−0.498***	Y	Y	Y	Y	910	0.683
	(0.024)	(0.130)	(0.096)	(0.114)	(0.516)	(1.197)	(0.339)	(0.200)	(0.067)						

Panel C: US sample

											Fixed effects				
Variables	RES	ROA	$ROA(-1)$	$ROA(-2)$	RD_A	$(RES \times RD\_A)$	INV_A	$Ln(\sigma^{TOTAL})$	IMR	$Controls$	$Industry$	$Country$	$Year$	Obs	R^2
(1)	0.155***								−0.852***	Y	Y	N	Y	1,108	0.771
	(0.051)								(0.048)						
(2)	0.145***	0.573***							−0.781***	Y	Y	N	Y	1,108	0.795
	(0.048)	(0.096)							(0.050)						
(3)	0.158***	0.406***	0.165**	0.207***					−0.688***	Y	Y	N	Y	757	0.788
	(0.054)	(0.064)	(0.064)	(0.064)					(0.050)						
(4)	0.194**				0.272	−1.426			−0.846***	Y	Y	N	Y	1,108	0.772
	(0.087)				(0.319)	(2.007)			(0.049)						
(5)	0.094**						3.131***		−0.879***	Y	Y	N	Y	1,108	0.817
	(0.037)						(0.344)		(0.043)						
(6)	0.158***							0.398*	−0.874***	Y	Y	N	Y	1,107	0.773
	(0.051)							(0.202)	(0.049)						
(7)	0.216***	0.443***	0.124**	0.197***	0.638**	−2.894*	2.194***	0.532***	−0.745***	Y	Y	N	Y	757	0.822
	(0.073)	(0.052)	(0.051)	(0.052)	(0.279)	(1.624)	(0.445)	(0.178)	(0.046)						

This table reports the pooled regressions with three-way industry, country and year fixed effects for the World (Panel A), European (Panel B) and US (Panel C) samples. The dependent variable is the year t log Tobin's Q ($Ln(Tobin's\ Q)$) in each regression while the independent variables are the year t-1 firm-specific explanatory variables. While the main explanatory variable is RES which measures a firm's level of resource efficiency, we include returns on assets (ROA) and its lags, R&D to total assets (RD_A), interaction term between RES and RD_A, capital investment to total assets (INV_A) and total risk ($Ln(\sigma^{TOTAL})$) in the regressions to account for their effects on firm values. In addition, we include four extra control variables, total debt to total assets ($LEVERAGE$), dividend yield (DY), net property, plant and equipment to total assets (PPE_A) and log total deflated assets ($Ln(Assets)$), in the regressions. The estimated coefficients and standard errors of these four control variables are unreported for brevity. Industry, country and year fixed effects are accounted for by introducing dummy variables in the World and European samples while industry and year fixed effects are controlled for in the US sample. While not all firms choose to disclose their resource usage, this choice introduces a possible self-selection bias into our sample and therefore could potentially affect the validity of our results. We follow the Heckman (1979) two-stage procedure and include the estimated inverse Mills ratios (IMRs) to the firm value regressions to adjust for selection bias. More details on the estimation procedure can be found in Section 4.4. The estimated coefficients, standard errors and R^2 are reported while the robust standard errors are clustered at firm level. '*', '**' and '***' denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 4: Causation regressions - Firm value regressions

2SLS	1^{st} Stage			2^{nd} Stage		
Dependent variable	*RES*			*Ln(Tobin's Q)*		
Sample	World	Europe	US	World	Europe	US
Models	(1)	(2)	(3)	(4)	(5)	(6)
Initial RES	0.646***	0.578***	0.486***			
	(0.041)	(0.069)	(0.092)			
Country RES	0.222*	0.007	17.256**			
	(0.125)	(0.159)	(8.085)			
RES				0.069***	0.078***	0.149*
				(0.017)	(0.037)	(0.086)
Firm Control	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	N	Y	Y	N
Year FE	Y	Y	Y	Y	Y	Y
Obs.	3,235	1,138	933	3,235	1,138	933
Hansen J-statistics				1.923	0.001	0.735
p-value				[0.166]	[0.974]	[0.391]
1^{th} *stage F-stat*	127.190***	34.610***	18.060***			

This table reports the results of the causation regressions as robustness checks to the firm value regressions reported in Table 3 for the World, European and US samples. We estimate two-stage least squares instrumental variable (2SLS IV) regressions using the country-year average *RES* (*Country RES*) and firm-level initial value of *RES* (*Initial RES*) as instruments for *RES*. Both *Country RES* and *Initial RES* are lagged by one year with respect to the *RES*. The F-tests of joint significance of the instruments in the first-stage regressions are reported in Columns (1) to (3). We also report the *J*-statistics of the Hansen test of over-identification in the second-stage regressions together with their p-values in Columns (4) to (6). The control variables include *ROA*, *RD_A*, *INV_A*, $Ln(\sigma^{TOTAL})$, *LEVERAGE*, *DY*, *PPE_A* and *Ln(Assets)* and the *IMRs* adjust for potential selection bias. Industry, country and year fixed effects are included by introducing dummy variables to the World and European samples while industry and year fixed effects are accounted for in the US sample. The estimated coefficients and standard errors of the instruments in the first-stage regressions are also reported in Columns (1) to (3) and for the *RES* in the second-stage regressions in Columns (4) to (6). The robust standard errors are clustered at firm level. '*', '**' and '***' denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 5: Firm value regressions - further robustness tests

							Stepwise
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RES	0.097***	0.112**	0.104***	0.100*	0.074**	0.090**	0.114***
	(0.033)	(0.049)	(0.040)	(0.055)	(0.035)	(0.036)	(0.042)
CEO_Age	−0.001	−0.000					
	(0.001)	(0.002)					
Ceo_Tenure	0.001	−0.001					
	(0.001)	(0.002)					
CEO_Gender	−0.045	−0.061					−0.072**
	(0.029)	(0.043)					(0.036)
CEO_Compensation		5.371					16.596
		(9.994)					(12.147)
CEO_Ownership		0.008***					
		(0.002)					
CEO_Duality		0.022					
		(0.018)					
Board_Age			0.001	−0.001			
			(0.003)	(0.004)			
Board_Tenure			0.005	0.005			
			(0.003)	(0.004)			
Board_Gender			0.135*	0.046			
			(0.080)	(0.090)			
Board_Size			−0.007	−0.007			
			(0.005)	(0.006)			
Board_Independence				0.015			
				(0.109)			
Board_Ownership				0.003			
				(0.003)			
Product					−0.014*		−0.014*
					(0.007)		(0.008)
Employee					0.003		
					(0.004)		
Diversity					0.005		0.008*
					(0.004)		(0.005)
Community					0.005		
					(0.007)		
Analyst_Coverage						−0.039*	
						(0.020)	
Analyst_Stdev						1.567	−2.596
						(2.150)	(1.914)
IMR	−0.807***	−0.713***	−0.793***	−0.694***	−0.838***	−0.863***	−0.823***
	(0.041)	(0.073)	(0.047)	(0.065)	(0.046)	(0.050)	(0.052)
Firm controls	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y
Obs	1,020	294	678	295	876	1,049	520
R^2	0.836	0.849	0.817	0.803	0.847	0.847	0.830

This table reports the results of the firm value regressions of the US sample, after controlling for factors relating to a firm's managerial and corporate governance characteristics, corporate social performance (CSP) and information uncertainty. The variables relating to managers include CEO age, tenure, gender, total compensation to total assets, ownership and duality and are included in Columns (1) and (2). The variables relating to corporate governance and board monitoring effectiveness include board age, tenure, gender, size, independence and ownership are included in Columns (3) and (4). The third set of variables in Column (5) measure a firm's CSP in terms of product innovation (Product), employee relations (Employee), diversity (Diversity) and relations with the community (Community) using the well known KLD ratings. Following Galema et al. (2008), for each CSP dimension we subtract the total number of concerns from that of strengths to measure net performance. The fourth set of variables in Column (6) includes analyst coverage and forecast dispersion which measure investor attention and information uncertainty. Column (7) reports the results of a stepwise regression with backward selection at a significance level of 0.2 using all variables except the CEO and board ownership variables. The control variables include ROA, RD_A, INV_A, $Ln(\sigma^{TOTAL})$, $LEVERAGE$, DY, PPE_A and $Ln(Assets)$ and the IMRs to control for potential selection bias. The industry and year fixed effects are included in the regressions while the robust standard errors are clustered at firm level. The estimated coefficients, standard errors and R^2 are reported. '*', '**' and '***' denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 6: Credit ratings regressions

Panel A: Distribution of rating data

		World		European		US	
Rating Variable	S&P Ratings	Obs.	%	Obs.	%	Obs.	%
7	AAA	33	2.89	1	0.23	28	4.62
6	AA+	10	0.87	5	1.16	3	0.50
6	AA	54	4.72	16	3.71	30	4.95
6	AA-	61	5.34	29	6.73	26	4.29
5	A+	84	7.35	18	4.18	63	10.40
5	A	170	14.87	31	7.19	123	20.30
5	A-	158	13.82	97	22.51	56	9.24
4	BBB+	212	18.55	104	24.13	77	12.71
4	BBB	154	13.47	63	14.62	70	11.55
4	BBB-	98	8.57	27	6.26	63	10.40
3	BB+	39	3.41	14	3.25	31	5.12
3	BB	25	2.19	14	3.25	7	1.16
3	BB-	15	1.31	5	1.16	12	1.98
2	B+	10	0.87	3	0.70	4	0.66
2	B	13	1.14	4	0.93	5	0.83
2	B-	5	0.44	0	0.00	6	0.99
1	<=CCC+	2	0.17	0	0.00	2	0.33
	Total	1,143	100.00	431	100.00	606	100.00

Panel B: Univariate analysis

	<=BBB+	>BBB+			
	RES	*RES*	Diff.	t-stat	Obs.
World	−0.030	0.045	0.075^{***}	3.637	1,144
Europe	−0.068	0.090	0.158^{***}	4.456	431
US	0.014	0.032	0.024^{**}	1.970	607

Panel C: Ordered logit regressions

Credit ratings	World		Europe		US	
	(1)	S.E.	(2)	S.E.	(3)	S.E.
RES	0.761^{***}	(0.249)	1.468^{***}	(0.401)	1.341	(0.953)
ROA	11.900^{***}	(1.975)	13.531^{***}	(4.273)	9.720^{**}	(4.436)
RD_A	−9.479	(6.805)	−4.980	(13.750)	3.399	(9.535)
INV_A	14.498^{***}	(5.113)	21.260^{*}	(10.847)	14.563	(11.261)
$Ln(\sigma^{TOTAL})$	-12.939^{***}	(4.114)	-15.065^{***}	(5.124)	−10.410	(6.803)
IMR	-4.652^{***}	(0.949)	-3.435^{**}	(1.459)	-4.322^{***}	(1.145)
Firm controls	Y		Y		Y	
Industry FE	Y		Y		Y	
Country FE	Y		Y		N	
Year FE	Y		Y		Y	
Obs.	1,140		429		607	
Pseudo R^2	0.409		0.521		0.407	

This table reports the distribution of our credit rating variable (Panel A), the results of the univariate analysis on the RES-credit rating relationship (Panel B) and the results of ordered logit regressions with three-way fixed effects using credit ratings as the dependent variables (Panel C). In Panel A, the number of observations and percentage of firms in each class of rating are reported for the World, European and US samples. In Panel B, we form two groups of firms, the first group has a credit quality equal to BBB+ or below in year t and the second group of firms have ratings above BBB+. We report the mean year t-1 RES, the difference in mean across the groups and the two-sample t-statistics. In Panel C, we report the results of the ordered logit regressions estimated with three-way fixed effects and the credit rating variable as the dependent variable for the World (Column (1)), European (Column (2)) and US (Column (3)) samples. The explanatory variables include RES, ROA, RD_A, INV_A, $Ln(\sigma^{TOTAL})$ and $IMRs$. The control variables $LEVERAGE$, DY, PPE_A and $Ln(Assets)$ are included, but their estimates are not reported for brevity. Industry, country and year fixed effects are included in the regressions for the World and European samples while only industry and year fixed effects are required for the US sample. The robust standard errors are clustered at firm level. The estimated coefficients, standard errors and R^2 are reported. '*', '**' and '***' denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 7: Causation regressions - Credit rating regressions

2SLS	1^{st} Stage			2^{nd} Stage		
Dependent variable	RES			$Credit\ Rating$		
Sample	World	Europe	US	World	Europe	US
Models	(1)	(2)	(3)	(4)	(5)	(6)
$Initial\ RES$	0.754^{***}	0.721^{***}	0.528^{***}			
	(0.055)	(0.086)	(0.156)			
$Country\ RES$	0.138	-0.085	7.440			
	(0.156)	(0.176)	(47.740)			
RES				0.429^{***}	0.580^{***}	1.525
				(0.124)	(0.202)	(1.211)
$Firm\ Control$	Y	Y	Y	Y	Y	Y
$Industry\ FE$	Y	Y	Y	Y	Y	Y
$Country\ FE$	Y	Y	N	Y	Y	N
$Year\ FE$	Y	Y	Y	Y	Y	Y
$Obs.$	1,108	419	596	1,108	419	596
$Hansen\ J\text{-}statistics$				1.761	1.111	2.020
p-value				[0.185]	[0.292]	[0.155]
1^{th} $stage\ F\text{-}stat$	93.090^{***}	44.840^{***}	11.670^{***}			

This table reports the results of the causation regressions as robustness checks to the credit rating regressions reported in Table 6 for the World, European and US samples. We estimate two-stage least squares instrumental variable (2SLS IV) regressions using the country-year average RES ($Country\ RES$) and firm-level initial value of RES ($Initial\ RES$) as instruments for RES. Both $Country\ RES$ and $Initial\ RES$ are lagged by one year with respective to the RES. The F-tests of joint significance of the instruments in the first-stage regressions are reported in Columns (1) to (3). We also report the J-statistics of the Hansen tests of over-identification along with their p-values in Columns (4) to (6). The explanatory variables include RES, ROA, RD_A, INV_A, $Ln(\sigma^{TOTAL})$. The firm control variables include $LEVERAGE$, DY, PPE_A and $Ln(Assets)$ and the $IMRs$ adjust for potential selection bias. Industry, country and year fixed effects are included by introducing dummy variables to the World and European samples while only industry and year fixed effects are required for the US sample. The estimated coefficients and standard errors of the instruments in the first-stage are reported in Columns (1) to (3) and for RES in the second-stage regressions in Columns (4) to (6). The robust standard errors are clustered at firm level. '*', '**' and '***' denote statistical significance at the 10%, 5% and 1% levels respectively.

APPENDIX

Table A.1: Variable definition

Variable	Description	Source
RES	Resource Efficiency Score. This is an average relative performance of a firm's efficiency in energy, water and waste usage. Energy consumption is measured by the level of absolute emissions of greenhouse gases from fossil fuel combustion, industrial processes and other sources owned or controlled by each company, and is captured by the amount of CO_2e. Water efficiency is measured as the costs generated by water utilized in operations taken directly from the ground, surface waters or purchased from local authorities. Waste efficiency is measured as the costs generated from the disposal of waste in normal company operations, classified as landfill, incinerated waste, recycled or nuclear waste. Each metric is scaled by firm revenue to generate a factor score for each component, which measures the rate of utilisation relative to total revenue. To account for the heterogeneity across industries, factor scores are standardised by subtracting the industry mean and dividing by its cross-sectional standard deviation to obtain z-scores for energy, water and waste efficiency for each firm. The three z-scores are averaged, weighted equally, to form a composite score. Higher resource efficiency is measured by a higher *RES*.	Osmosis Investment Management
ROA	Return to assets computed as the income before extraordinary items to total assets.	Worldscope, Compustat
RD_A	Research and development (R&D) intensity calculated as the total R&D expenditures to total assets.	Worldscope, Compustat
INV_A	Investment intensity, is the total capital expenditure to total assets.	Worldscope, Compustat
$Ln(\sigma^{TOTAL})$	Natural log of one plus total risk. A firm's total risk is measured by the annualised standard deviation of its stock's monthly returns over the 12-month period before its fiscal year-end.	Datastream, CRSP
LEVERAGE	Leverage ratio measured as total liabilities to total assets.	Worldscope, Compustat
PPE_A	Asset tangibility is computed as net property, plant and equipment to total assets.	Worldscope, Compustat
DY	Dividend yield is dividend per share to stock price at the fiscal year-end.	Worldscope, Compustat
$Ln(Tobin's\ Q)$	Natural log of one plus Tobin's Q. Q is measured by the market value of equity minus the book value of assets and equity, all divided by total assets.	Worldscope, Compustat
Assets	Total book value of assets (in real terms). The total assets of the World sample are deflated by their respective domestic GDP deflator with a base year of 2009, or by their domestic CPI indices if this is not available. The domestic GDP deflator and CPI indices are downloaded from the Federal Reserve Economic Data (FRED) web site, accessed via: http://research.stlouisfed.org/fred2/. If both the country's GDP deflator and CPI index are not available on the FRED web site, we obtained the information from their respective national census web sites.	Worldscope, Compustat, FRED, national census web sites
$Ln(MCAP)$	Natural log of one plus market capitalisation. The market capitalisation is computed as the product the stock price and the number of outstanding shares as at end of December in calendar year t-1.	Worldscope, Compustat, CRSP, Datastream
CEO_Age	CEO Age	Compustat Execucomp
CEO_Tenure	CEO Tenure is defined as the number of years the CEO has been in the current position.	Compustat Execucomp
CEO_Gender	Management diversity. A dummy variable equal to one when the CEO is female and zero otherwise.	Compustat Execucomp
CEO_Compensation	CEO pay is calculated as the CEO's total compensation to total assets.	Compustat Execucomp
CEO_Ownership	Share ownership of the CEO is computed as the number of shares owned by the CEO divided by the total number of shares outstanding.	Compustat Execucomp
CEO_Duality	CEO power is measured by a dummy variable which equals one when the CEO is also the chairman of the Board of Directors.	Compustat Execucomp
Board_Age	Board age reflects the average age of the independent directors in a given fiscal year.	IRRC
Board_Tenure	Board tenure represented as the average number of years the independent directors have been in the current position.	IRRC

Board_Gender	Board diversity is the proportion of independent directors that are female in a given fiscal year.	IRRC
Board_Size	Board size is the total number of board members.	IRRC
Board_Independence	Board independence is the ratio of independent directors to the total of board members.	IRRC
Director_Ownership	Share ownership of the independent directors captures the average percentage share ownership of the independent directors.	IRRC
Product	CSP score for the product innovation dimension (total number of strengths minus the total number of concerns).	KLD ratings from MSCI
Employee	CSP score for the employee relations dimension.	KLD ratings from MSCI
Diversity	CSP score for the diversity dimension.	KLD ratings from MSCI
Community	CSP score for the community relation dimension.	KLD ratings from MSCI
Ln(*Analyst_Coverage*)	Natural log of one plus the analyst coverage variable. Analyst coverage is measured by the average monthly number of analyst forecasts (fiscal year-end EPS forecast).	I/B/E/S, CRSP
Ln(*Analyst_Disp*)	Natural log of one plus the analyst dispersion variable. Analyst dispersion is the average monthly forecast standard deviation scaled by its fiscal year end closing stock price.	I/B/E/S, CRSP