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Political and Socioeconomic Factors That Determine the Financial Outcome of Successful Green Innovation

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Abstract: Green innovation and technology diffusion must be financially and commercially attractive to convince corporate decision makers. This paper focuses on the factors that determine the financial outcome of successful green innovation activities conducted by large, listed companies. We employ a cross-industry dataset including more than 97,954 reports on corporate environmentalism from 286 international listed companies. Our results indicate that economic, political, cultural, firm-specific, investor-related, and governance factors significantly determine the financial performance of green innovation, measured by abnormal returns. Moreover, we can show that factors that reduce the competition in green innovation markets benefit the financial success of firms operating via them. Finally, we find an opposing influence for several factors that benefit earlier stages of innovation (e.g., research output) while harming the later stages (e.g., market introduction and financial performance). These findings imply that a spatial separation strategy for different stages of innovation supports corporate environmentalism activities. Moreover, physical property rights, the governments' willingness to support green technologies, and economic framework conditions such as oil price, GDP, or public R&D budget need to be balanced by policymakers to address and stimulate green innovation.

Keywords: green innovation; corporate environmentalism; Porter hypothesis

JEL Classification: C58; G14; Q56

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1. Introduction

Climate change, pollution of the environment, and the consecutive challenges for the 21st century have been increasingly recognized by governments, policymakers, and industry over the last decade. It is therefore vital to transition from environment- and resource-intensive trajectories to more sustainable growth paths for the global economy. This also requires corporate environmentalism and (green) technological innovation [1]. To realize sustainable growth paths, green innovation and technology diffusion must be financially and commercially attractive to convince corporate decision makers to introduce environmentalism [2]. The current strand of literature on the financial attractiveness of green innovation can be divided into two parts [3]: the traditional view follows Friedman [4] and considers green innovation as firm-value decreasing, while the Porter hypothesis [5] argues that environmental policies, adoption of corporate environmentalism, and green innovation increase profits of firms by reducing costs and increasing revenues. In fact, prior studies provide empirical evidence to support the Porter hypothesis for many cases [6]; however, we do not yet observe the global economy moving towards green, sustainable societies in the current growth path. Previous studies found three main barriers causing companies to fail in corporate environmentalism: market failure and deficiencies; regulatory issues; and financial problems for green innovation [7]. Therefore, scholars have suggested intervention by governments to overcome these barriers [8,9]. Government organizations included environmental issues into their agendas for multiple decades now. As a result, different forms of intervention were introduced, ranging from regulatory (e.g., forced shutdowns or investments) to market-based, economic measures (e.g., supply-push and demand-pull) [8,10]. One of the most important green growth strategies from a governmental perspective is the development of green technologies through appropriate innovation to stimulate corporate environmentalism, particularly green innovation policies [11].

Obviously, the level of complexity of these challenging issues is high, and therefore a better understanding of the factors determining the financial attractiveness of corporate environmentalism and green innovation is essential to support the application of governmental instruments. Extensive research on the financing problem of green innovation has taken place already, especially in green banking [12–16], crowdfunding [17–19], venture capital [1,20,21], foreign direct investments [22–24], and mergers and acquisitions [25]. While most of these studies focused on the early stages of the innovation process (such as research activity) and the early outcomes (such as patents), there is a lack of studies that explore the later stages of innovation such as diffusion and market adoption, commercialization, and financial outcomes for companies. Moreover, sustainability efforts, such as green innovation-related investments, research and development (R&D), patents, and market adoption differ between cities, regions, and countries. Previous works tried to explain these differences via different factors, such as cultural values [17,23,26], availability of education and research facilities [27–30], macroeconomic variables [12,31–33], geographic resources [34–38], firm-level determinants [26,39–41], and governmental regulations [11,31,42,43]. Most of these works, however, focus on the renewable energy industry rather than allowing a cross-industry view. They also focus on small regional areas and do not offer a global examination, and are mostly related to crowdfunding, start-up financing, and small and medium-sized enterprises (SME). Research on larger (listed) companies is more sparse, achieving little attention in the literature; however, previous works have found that larger companies could play a leading role in innovation due to their greater resources for R&D [44].

The goal of this study is to extend the literature by contributing to a better understanding of the factors that determine the financial outcome of successful green innovation activities by listed companies from different industries and countries around the world. We employ a large, global, cross-sectoral dataset including more than 97,954 news articles that report on corporate environmentalism from 286 listed companies and 32 different countries over 13 years. Our findings show that economic, political, cultural, firm-specific, investor-related, and governance factors significantly determine the financial performance of green innovation, and that higher levels of incentivization harm the competition-sensitive, green-innovating firms.

The remainder of this paper is structured as follows. Section 2 revisits the ongoing discussion on the profitability of corporate environmentalism, summarizes findings on the barriers of green innovation, presents studies on factors that explain differences in sustainable efforts, and derives the hypotheses for this study. Section 3 describes the materials, methods, and models, and Section 4 presents the empirical results. Section 5 interprets and discusses the findings in the context of previous works. The paper ends with a conclusion, which highlights the significance of this work, provides implications for policymakers and firm managers, and discusses research limitations and future studies.

2. Literature Review

Corporate environmentalism is the process by which firms recognize and integrate environmental concerns and pledge to undertake actions beyond the requirements of the law, in such a way that firm-level efforts are made to reduce pollution and resource use along with protecting natural habitats [45,46]. One of the most important measures to implement a green growth strategy is an innovation based on green technologies [11].

This literature review is divided into three parts. The first part revisits the ongoing discussion on whether green innovation and corporate environmentalism are profitable for enterprises. The second part summarizes prior findings on the barriers of green technology-related innovation. The third part presents current analyses on which factors might explain the differences in sustainable efforts across different regions.

2.1. Financial Benefits of Corporate Environmentalism

Two schools of thought can be found in the literature on the question of whether corporate environmentalism is financially beneficial for firms [3]: (i) the traditional view starting with Friedman [4] and (ii) the modern view starting with Porter's hypothesis [5]. The traditional view postulates that financial efforts towards corporate environmentalism are linked to negative financial firm performance, while the modern view oppositely hypothesizes that green innovation and efforts benefit the financial performance due to increased revenues and reduced costs.

Previous studies have found many examples to support both the traditional view [2,7,15,47] and to support Porter's hypothesis [2,3,6,7,48,49]. Objects of research at different levels ranging from start-ups [17,32] to SMEs [3], large stock companies [6,48] and banks have been part of these investigations. Stefan et al. [7] argue that investments to reduce pollution can be returned elsewhere. They summarize the positive links between environmental and economic performance in seven opportunities for increasing revenues and reducing costs by green means. On the one hand, revenues can be increased by better access to certain markets, product differentiation, and sales of pollution-controlling technologies. On the other hand, costs can be cut due to corporate environmentalism, as risk management can be mitigated and costs related to external stakeholder relationship management reduced. Moreover, the costs for material, energy, and services can be reduced due to green efficiency improvements, as well as the costs of capital and labor can be lowered [13].

Despite the empirical evidence supporting Porter's hypothesis, we do not observe that the global markets are shifting to green, sustainable economies yet. Researchers tried to gain a better understanding of the drivers behind the mechanism. According to Orsato et al. [2], successful sustainability strategies take place in a certain win–win area on the public benefits vs. private profits plane. Only a few actions of corporate environmentalism will generate economic returns, and this is most likely to happen in win–win areas with low competition with existing products/technologies, as shown in Figure 1.

With regards to the discussion on the financial benefits of corporate environmentalism [10], we assume that factors reducing the competition might benefit the financial success at later stages of green innovation projects. This could also mean that the impact of certain factors might differ in terms of the effect's sign. For instance, while rising resource prices for oil, gas and coal were found to incentivize research (early stages) on green innovation [50], we assume that it will also increase the competition and thus reduce the financial outcome at the later stages:

Hypothesis 1. *Factors that reduce the competition in green innovating markets will positively impact the financial returns of firms (at later stages of the innovation process) operating on these markets.*

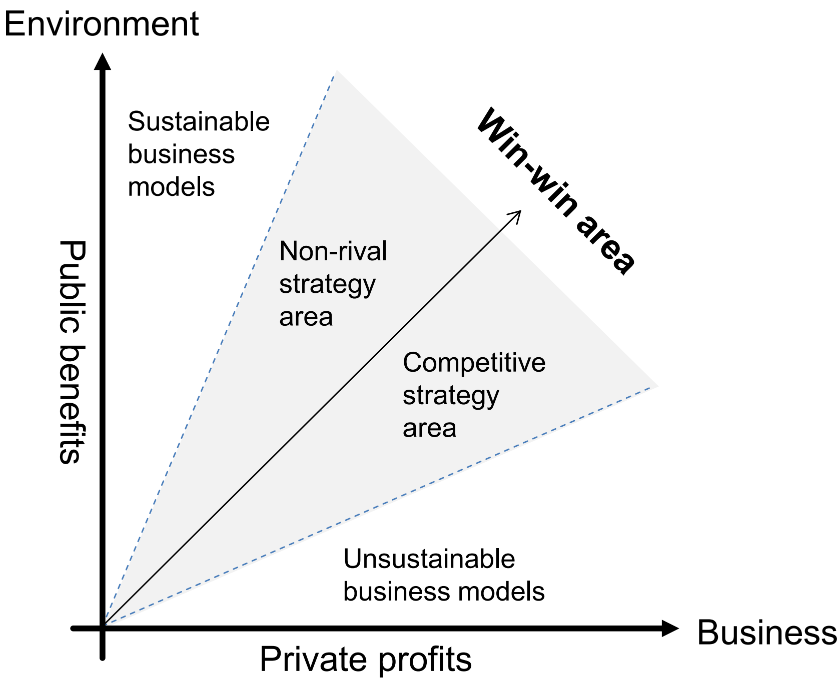

Figure 1. Successful green innovation is to happen most likely in win–win areas under nonrival strategies. Adapted with permission from ref. [2]. 2009 Orsato et al., with permission from Springer Nature.

2.2. Barriers of Green Technology-Related Innovation

Previous studies find mainly three barriers for companies failing in corporate environmentalism: market deficiencies, regulatory issues, and financial problems for green innovation [1,7,8,51].

Markets seem not to be able to solve environmental issues due to three main deficiencies [8]. First, markets fail to internalize environmental externalities, meaning that companies can generate profits at the cost of the nature or later generations. While the internalization of environmental externalities is a key component in sustainability, taxation works most efficiently in elastic demand scenarios [44]. The assessment and inclusion of the interests of future generations is highly challenging, which is why protecting their interests can be assured through the preservation of fundamental environmental rights [52]. Second, markets suffer from free-riding, meaning that consumers have a low willingness to pay premiums for protecting public goods. Previous works on free-riding distinguish single-shot games, in which players do not need to take into account the impact of their current action on the future actions of other players, and repeated games, in which players need to. No significant evidence was found for the free-riding strategy (meaning benefiting from other players investing into a public good while not contributing) in single-shot games. However, in repeated games, a decay towards free riding with each round could be observed [53]. Similarly, the market participants' decision between cheaper or greener products and services (with a price premium) represents a repeated game, and evidence for free-riding is present in the literature [8,54]. Third, markets suffer from spill-over effects, meaning that there are insufficient market signals and incentives for firms to conduct research on green technologies, as other firms will profit from them. Innovation happens at the interplay between competition and cooperation. Previous works observed environmental innovative firms cooperate with competitors to a higher extent than other firms, as firms are relatively more in need of external knowledge to innovate. On the one hand, this can help companies to save R&D efforts, but on the other hand, is accompanied by the risk of spill-overs and free-riding cooperation partners [54,55]. To summarize, these three deficiencies impede sustainability efforts and scholars encourage governmental intervention [8,9].

Enzensberger et al. [10] differentiate between legislative, nonlegislative, as well as regulatory measures, such as forced shutdowns or investments, and market-based, economic measures, such as supply-push and demand-pull (see Figure 2 as a reference). Moreover, governments can intervene with environmental taxation [11,33], intellectual property right enforcement [31], and public R&D expenditure [11]. Governmental intervention tends to have a rather long-term impact, and mixed outcomes are observed depending on context and implementation by policymakers [10,31,32]. In addition to that, studies find that long-term policy stability is one of the key factors determining whether the desired outcomes of sustainability strategies can be achieved through governmental intervention [1,31]. Besides, green policy instruments can be grouped into penalties (sticks) and incentives (carrots). Previous works found evidence for the potency of both, but sticks proved to be the more efficient public policy instrument [44].

Innovative businesses require different forms of financing as they grow. Conditional on firm size, firms have access to different financing options. Extensive research on the financing of green innovation is yet to take place. From companies' perspectives, previous research has investigated various forms of financing of start-ups [17–21,32,51,56], and SMEs [1,3,24,25,57,58]; however, studies on larger corporations can also be found [6,8]. Firms usually acquire access to capital via venture capital [1,20,21,32,56,58], mergers and acquisitions [12,25], crowdfunding campaigns [17–19], foreign direct investments [22–24], public R&D budgets [8,31,51], and private investments from industry [59,60] and banks. Previous studies show that the most established channels are venture capital and mergers and acquisitions, as most green innovation investments are related to relatively higher risks [12,24]. From the (financial) markets perspective, previous research explored the decarbonization of balance sheets [12,13] and green financial products, such as green index funds and green bonds [14–16]. Due to the larger levers of banks and markets, governments increasingly address financial institutions and establish conditions to promote green investments [1,7,8,31,61].

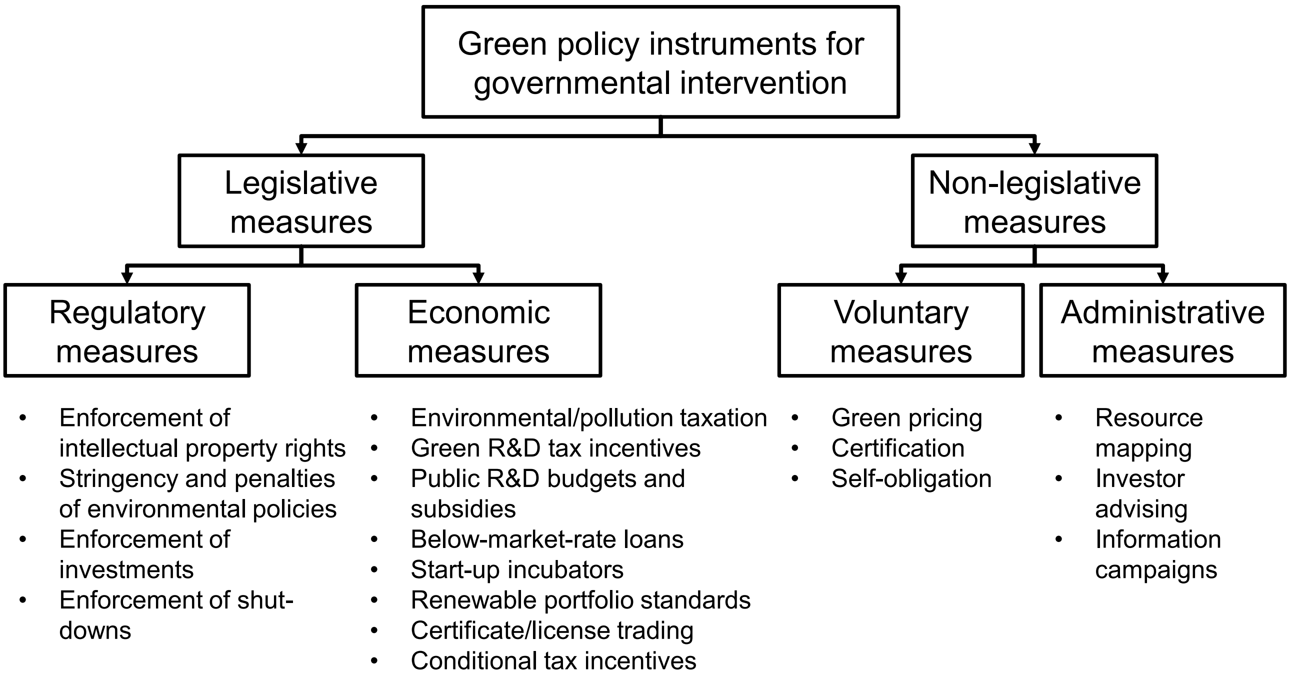

Figure 2. Green policy instruments for governmental intervention cover legislative and non-legislative measures. Adapted with permission from ref. [10]. 2002 Enzensberger, with permission from Elsevier.

2.3. Factors Explaining the Differences in Sustainability Efforts

Potentially, the more interesting question to answer is not whether green innovation pays off, but rather which factors determine the success (firms' returns related to green innovation). Previous works observe that efforts in sustainability, such as green innovation-related investments, research and development, patents, and market adoption differ between cities, regions, and countries. These studies investigate the earlier phases of innovation, including the front-end and early development, rather than production-ready products and market diffusion. R&D budgets, investments, and number of patents published count amongst the metrics investigated by these works. Nonetheless, factors that determine the earlier stages of innovation might also help to answer the question of the financial attractivity of green innovation (appearing at the later phases of innovation). Studies show that differences can be explained by different factors, such as cultural values [17,23,26], availability of education and research facilities [27–30], macro-economic variables [12,31–33], geographic resources [34–38], firm-level determinants [26,39–41], and governmental intervention [11,31,33,42,43].

Culture can be defined as the collective mental programming of the human mind which distinguishes one group of people from another. This programming influences patterns of thinking which are reflected in the meaning people attach to various aspects of life, including language, cuisine, social habits, religion, music, and arts, and which become crystallized in the institutions of a society [62,63]. Hofstede [63] identified six dimensions to capture different aspects of culture, including power distance, individualism vs. collectivism, masculinity vs. femininity, uncertainty avoidance, long-term orientation, and indulgence vs. restraint. In the context of green technologies, previous studies found that cultural differences can influence foreign direct investments [22,23], public R&D budgets [26], the success of policies [27,28], green banking [12], and crowdfunding campaigns [17,19]. Indeed, metrics based on the Hofstede dimensions have been used to quantify different aspects of culture in previous works [17,31].

Strong public institutions for education and research, such as universities, have been shown to contribute to long-term and sustainable growth paths [27]. The lack of industrial R&D facilities and university co-operations are the main impediment for green technology-related start-ups [30]. Therefore, facilitated access to talents and technologies that enable corporate capabilities are vital to support green entrepreneurship [29], as large shares of green innovation are driven by start-ups and SMEs with only a few resources for R&D and headcounts [8,64].

Research also investigates the impact of macroeconomic variables on corporate environmentalism and green innovation. Besides gross domestic product, economic growth, and energy prices, prices for competing resources such as coal and gas play an important role in corporate sustainability efforts [12,31–33]. Oil is the "lifeblood of modern economies" and by some estimates more than 90% of everything that is produced currently uses oil at some stage of the value chain [32]. Rising oil prices, therefore, provide a strong incentive to either conduct research on reduction of resource use or to switch to processes with alternative fuel sources, like renewable energies [50].

Another important factor that determines the emergence of corporate environmentalism is the availability of geographic resources. Studies show that scarcity of natural resources can foster more efficient resource utilization [34]. Similarly, the richness of natural resources, such as water and wind, can serve the emergence of sustainability efforts, such as hydropower [35,37] and wind-power [38]. Moreover, the level of urbanization is important [35,36] and the findings of [38] describe sustainability efforts as the convergence of natural, social, and economic influences.

Research also focused on firm-level determinants for corporate environmentalism. Firm properties such as protectability and proactiveness [65] and entrepreneurial orientation [39] can determine the success of green innovation. Moreover, firm learning and knowledge capital are vital for companies to successfully drive green innovation [26,41]. In this context, prior works emphasize the path dependency of a company, meaning that historical success stories in green innovations reinforce and determine future success [40,41].

Finally, the influence of government intervention is a crucial determinant for the success of green innovations. As shown before, governmental intervention is important to solve the market deficiencies internalization of environmental externalities, free-riding problems, and spill-over effects [8,9]. Evidence was found for the influence of economic, market-based policy instruments such as environmental (pollution) taxation, green R&D tax incentives [42], and public R&D budgets [11] on corporate sustainability efforts. Results indicate an u-shaped relationship between environmental taxation and sustainability efforts, with an optimum right between inhibition and promotion [42]. Public R&D budget expenditure on green innovation has a positive impact on the number of green technology-related patents [11,31]. Moreover, studies on the effect of regulatory instruments show the relevance of enforcement of intellectual property rights [11] and stringency of environmental policies [31]. Contrary to the expectation that the enforcement of intellectual property rights could mitigate spill-over effects, findings indicate a negative impact on research activity [11]. The stringency of environmental policies has shown a positive impact [31]. Moreover, the stability of policy [1,43] and protection of investors (anti-director rights) [32] were found to have a positive influence.

As previous studies provide evidence for the influence of the many factors discussed above on the success of green innovations at the earlier stages, we would like to explore whether this is the case of the latter stages of innovation:

Hypothesis 2. *Factors such as cultural values, macroeconomic variables, geographic resources, firm-level determinants, and governmental intervention do influence the success of corporate environmentalism and green innovation at later stages, such as financial outcome, market diffusion, and adoption.*

3. Materials and Methods

In this study, we investigate the influence of political and socioeconomic factors on the financial outcome of successful green innovation. We observe the innovation activities of more than 344 firms and 286 related stock companies from 32 different countries and 14 different industries that were documented in 97,954 articles in dedicated online magazines from 2004 to 2017.

We measure the financial success by abnormal returns of the stock prices using event study analysis [66]. The articles' publication date is considered to be the event of interest. Consecutively, we aim to model and explain the abnormal returns of successful green innovation by different factors including political, cultural, investor-related, governance, economic and firm-specific factors.

3.1. Construction of Dependent Variable

The event study approach is based on the assumption that capital markets are efficient and thus reflect the impact of all new information on the future expected profits of listed companies [67]. A given event, such as the publication of novel and market-relevant information, hence causes a deviation in a securities' pricing. We selected 10 online magazines as sources for this investigation. Together, they form the largest set of news on green technologies with the largest attention in terms of audience for the given observation period [66]. A summary of the magazines can be found in Table 1. The security price timeline is divided into three distinct time windows around the event of interest: the estimation window, the event window, and the postevent window.

The security price data of the estimation window is used to model the security price for predictions during the event window. The difference of predicted and actual returns during the event window equals the abnormal returns [68]. Within this study, we employ two types of return models: constant mean return model (CMR) and market model (MM). The CMR model assumes the mean of a given security to be constant over time, whereas MM assumes a stable linear relation between market return and security return [68]. Despite its simplicity, the CMR model achieves surprisingly good results in contrast to the MM model [69]. Usually, country-specific indexes are selected to measure market movements for the MM model. Here, we use country-specific MSCI World indices. Stock market and index data were obtained from Refinitiv (formerly Thomson Reuters). As described in a previous study [66], we quantify the financial performance by cumulative abnormal returns (CAR), which were calculated with a 180-day estimation window before and a 2-day event window around the event of interest. As the CAR value suffered from high skew and kurtosis, the CAR values were transformed by the double of the square root.

Table 1. The 10 selected online magazines that report news about green innovation. Note: The number of events (# Events) refers to the number of articles with positive CAR using CMR model. Information and articles gathered on 22 October 2017).

Magazine	URL	# Events
GreenCarCongress	https://www.greencarcongress.com/	19,321
BioBasedNews	https://news.bio-based.eu/	2408
TechCrunch	https://www.techcrunch.com/	1586
PhysORG	https://www.phys.org/	2441
TechXplore	https://www.techxplore.com/	204
CleanTechnica	https://www.cleantechnica.com/	14,291
CleanTechies	https://www.cleantechies.com/	1786
EVObsession	https://www.evobsession.com/	3207
Gas2ORG	https://www.gas2.org/	654
SolarLove	https://www.solarlove.org/	726
Total		46,624

3.2. Description of Independent Variables

Various independent variables are used to determine the success measured by changes in the stock market valuation around the announcement of green innovation events. All web sources that are mentioned in the following were accessed on 22 October 2017. Economic factors encompassed the prices for fossil (conventional) sources of energy and material such as oil, coal, and gas (prices for oil, coal, and gas were gathered from the "BP Statistical Review of World Energy 2017" https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html, accessed on 22 October 2017) and the national gross domestic product and per capita value (the gross domestic product and per capital value were gathered from the International Monetary Fund DataMapper (http://www.imf.org/external/datamapper/NGDPD@WEO/OEMDC/ADVEC/WEOWORLD, accessed on 22 October 2017) under Datasets > World Economic Outlook > Gross Domestic Product (GDP), accessed on 22 October 2017). Moreover, we included the economies' annual R&D budget (Data gathered from the Organisation for Economic Co-operation and Development https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm, accessed on 22 October 2017). This includes the total R&D spending from all universities, companies, and governmental institutions. Values represent the share of the gross domestic product. Firm-specific factors include stock price, market capitalization, and earnings before interests and taxes (EBIT) (all financial data was obtained from Refinitiv (formerly Thomson Reuters)). Cultural factors are captured by six of the Hofstede Cultural Dimensions (the cultural values are sourced from Geert Hofstede's webpage http://geerthofstede.com/research-and-vsm/dimension-data-matrix/, accessed on 22 October 2017) and cover individualism, power distance, masculinity, uncertainty avoidance, long-term orientation, and indulgence [70]. Governance factors comprise the Worldwide Governance Indicators (the Worldwide Governance Indicators are obtained from The World Bank Group info.worldbank.org/governance/wgi/index.aspx#home, accessed on 22 October 2017) [71] and factors from International Property Rights Index (the

International Property Rights Index data was gathered from the Property Rights Alliance at https://www.internationalpropertyrightsindex.org/countries, accessed on 22 October 2017). Governance consists of the traditions and institutions that determine how authority is exercised in a country. This includes processes, such as government selection, monitoring and replacement, and the governments' ability to effectively formulate and implement sound policies, as well as the respect of citizens [71]. More specifically, the Worldwide Governance Indicators include voice and accountability, political stability, governmental effectiveness, regulatory quality, rule of law, and corruption control. In addition to these values, we consider political stability, rule of law, and control of corruption from the International Property Rights Index. Political factors include the Environmental Policy Stringency Index [72] and the public R&D budget (environmental Policy Stringency Index and public R&D budget data gathered from the Organisation for Economic Co-operation and Development https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm, accessed on 22 October 2017). Values for the R&D budget represent the share of the gross domestic product as well as the governments' willingness to become greener, measured by the Clean Tech Group Country Index (the Clean Tech Group Country Index values were gathered from https://i3connect.com/gcii, accessed on 22 October 2017. A report on the calculation is available here http://info.cleantech.com/CleantechIndex2014.html, accessed on 22 October 2017). Investor-related factors comprise the Anti-Director-Rights (the Anti-Director-Rights quantify the rights that protect investors' interests) [73], and several of the International Property Rights Indices (The International Property Rights Index data is obtained from the Property Rights Alliance at https://www.internationalpropertyrightsindex.org/countries, accessed on 22 October 2017. We consider the (overall) International Property Rights Index, the patent protection index, and the intellectual property protection index.)

As the prices for oil, gas, coal, the stock price, the market capitalization, and the gross domestic product and per capita values suffer from high skewness and kurtosis we consider their transformation by natural logarithm. Moreover, the values of all variables are normalized by their mean and standard deviation. Finally, outliers are removed using the isolation forest model [74,75] at a prediction score smaller than −55% (isolation forest implementation documentation in the sklearn package can be found here https://scikit-learn.org/stable/modules/generated/sklearn.ensemble.IsolationForest.html#sklearn.ensemble.IsolationForest.score_samples, accessed on 22 October 2017). We use the isolation forest model as it requires few parameters, and it is distribution-assumption-free and fairly robust.

3.3. Exploratory Factor Analysis

After analyzing the independent variables for multicollinearity using correlation matrix and variance inflation factors [76], we discovered the need for variable transformation before we could continue the modeling process using regression analysis. We decide to choose exploratory factor analysis [77] for dimensionality and multicollinearity reduction. Factor analysis is an exploratory data analysis method used to extract influential underlying factors (latent variables) from a set of observed variables and to rotate these to increase interpretability. Factor Analysis assumes that the data is outlier-free, that there is no perfect multicollinearity and heteroscedasticity between the variables. Exploratory factor analysis assumes that observed variables are directly associated with factors. We conduct Bartlett's test of sphericity [78] to test heteroscedasticity and the Kaiser–Meyer–Olkin test [79] to assess the adequacy of factor representation. Afterward, we applied the Kaiser–Guttman–Dickman criterion [80,81] to determine the optimal number of factors. Finally, we conducted Factor Analysis (we used the python package FactorAnalyzer. Documentation can be found here https://factor-analyzer.readthedocs.io/en/latest/index.html, accessed on 22 October 2017) using Oblimax rotation [82] as it provided the best results in the decorrelation of variables while keeping a high share of explained variance.

3.4. Modeling and Regression Analysis

As we want to analyze factors on the financial outcome of successful green innovation, our data set consists of all events with positive CAR. Three different regression models were used in the analysis for robustness checks. First, we employ linear regression models with ordinary least square estimation [76]. As the dependent variable (CAR) is truncated on the left side at zero, we decided to supplement the investigation with truncated regression models [83]. As the resulting residuals suffered from heteroscedasticity, we repeated the investigation with a heteroscedasticity-robust truncated regression model (CRCH) [84]. We report R^2 and adjusted R^2 [76] to assess the quality of the regression models. Moreover, we report the overall F-test, Student's *t*-test, and Wald's z-test [76] to quantify the significance of the explanatory variables and models.

In addition to this, residual analysis was performed for the normal distribution assumption (using Shapiro–Wilk [85] and Kolmogorov–Smirnov [86] tests) and the non-heteroscedasticity assumption (using Breusch–Pagan [87], Goldfeld–Quandt [88], Fligner–Killeen [89], and Levene [90] tests (the python package statsmodel was used as an implementation of Breusch–Pagan and Goldfeld–Quandt tests. Documentation can be found here https://www.statsmodels.org/dev/generated/statsmodels.stats.diagnostic.het_breuschpagan.html, accessed on 22 October 2017 and here https://www.statsmodels.org/dev/generated/statsmodels.stats.diagnostic.het_goldfeldquandt.html, accessed on 22 October 2017. The python package scipy.stats was used as an implementation of Fligner–Killeen and Levene test. Documentation can be found here https://docs.scipy.org/doc/scipy/reference/generated/scipy.stats.fligner.html, accessed on 22 October 2017 and here https://docs.scipy.org/doc/scipy/reference/generated/scipy.stats.levene.html, accessed on 22 October 2017). We used R v4.0.2 [91] and the packages lm [92,93], truncreg [94] and crch [84,95] for implementing these models.

4. Results

4.1. Descriptive Statistics

Table A1 summarizes our descriptive statistics for the dependent and independent variables. Figure 3 describes the dependent variable (CAR) by industries, continents, years, and magazines. The CARs based on the CMR and MM models correlate and resemble highly with each other. The CMR estimates provide higher values than the MM estimates, as previously observed in [66] and shown by differences in arithmetic mean and standard deviation in Table A1. The breakdown by years reveals a stable average CAR of around 2.25% during the observation period, which indicates that possible relationships can be analyzed without any long-term trends that have to be taken into account. The breakdown by magazines reveals that there is no bias caused by the magazines as CARs are almost equally high. The lower two breakdowns reveal specific differences between continents and industries. On the one hand, North and South American green activities by listed companies seem to be slightly more successful than European and Australian ones. These differences are, however, small. On the other hand, differences between industries are larger and especially the vehicle and basic resources industry seem most successful. The high variance inflation factors (see VIF in Table A1) of the dependent variables with values far above 1.0 express that the independent variables intercorrelate strongly and indicate multicollinearity problems.

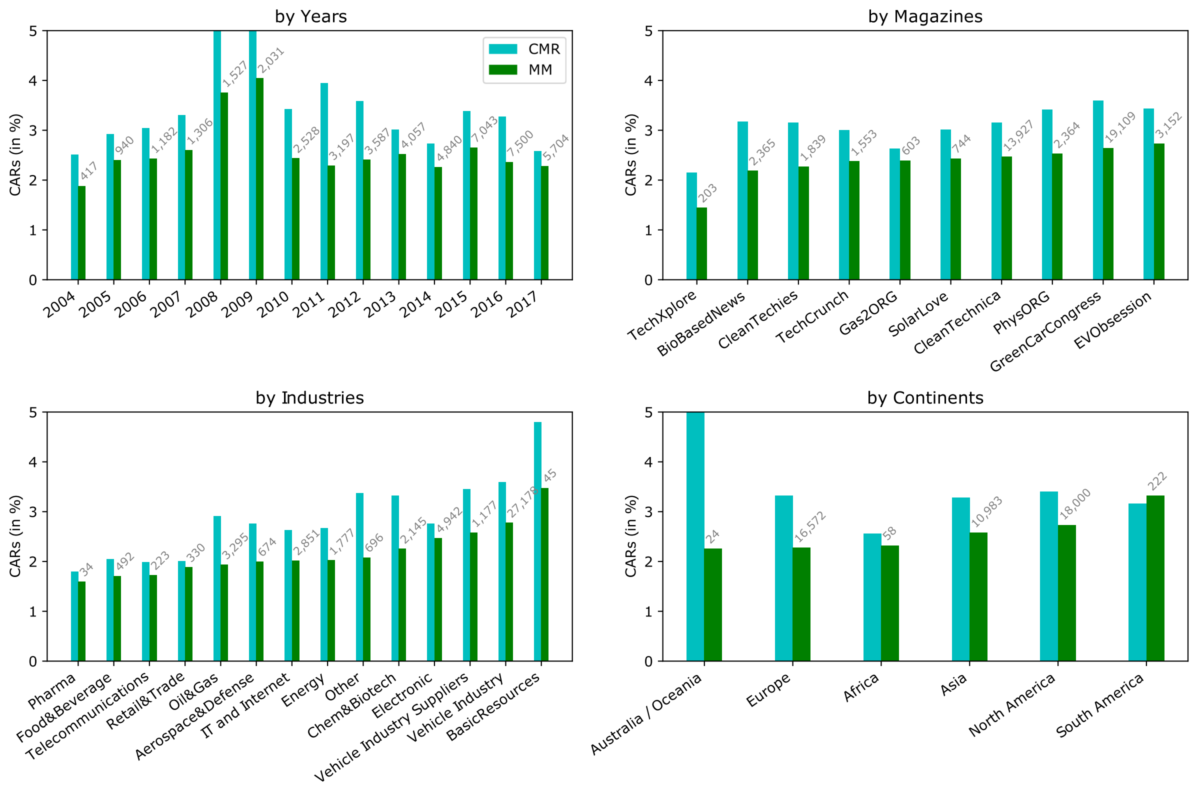

Figure 3. Descriptive statistics of dependent variable: breakdown of CARs by different aspects. Gray numbers represent the number of events per aspect.

4.2. Exploratory Factor Analysis

As a consequence, we chose to apply exploratory factor analysis to reduce the dimensionality (32 independent variables) and to decorrelate. The Bartlett's test of sphericity [78] ($1,967,740.45$, $p = 0.0$ ***) significantly indicates that the correlation matrix of the independent variables does not equal the identity matrix and therefore confirms the applicability of the given data for factor analysis. The Kaiser–Meyer–Olkin test [79] (0.62) measures the adequacy of the given data for factor analysis and the result supports the application of factor analysis (as the value is larger than 0.6). The application of the Kaiser–Guttman–Dickman criterion [80,81] indicates the selection of seven factors. Table 2 shows the results of the exploratory factor analysis. The seven factors together explain more than 88.73% of the total variance of the data set. A selection of dominant independent variables by factor loading facilitates the interpretation of the given factors. We find and interpret the seven factors as follows: (i) cultural factors, (ii) stability, rule of law, (iii) investor rights and indulgence, (iv) economic factors, (v) environmental policy, (vi) firm-specific factors, (vii) governance factors. The eigenvalues underline the choice of seven factors, as for the given seven factors they are almost greater or even to one (the following eigenvalues are below 0.5). The variance inflation factors (VIF) show values close to one, which means that the resulting factors are almost uncorrelated. Therefore, the use of the factors instead of the independent variables overcomes the problem of multicollinearity. An overview of all factor loadings can be found in Table A2.

Table 2. Extracted Factors and their Interpretation.

Factor (Cum.var.expl.)	**Interpretation (Selected Dominant Independent Variables)**	**Eigenvalues (VIF)**
1	Cultural factors	11.0862
(34.41%)	NCDI (POW, 94%; UNC, 88%; MAS, 78%)	(1.00011)
2	Stability, Rule of Law	8.2045
(59.79%)	IPRI (Legal, 84%; Overall, 82%, Pol. Stability, 73%)	(1.00003)
3	Investor Rights and Indulgence	3.0202
(68.86%)	ADRI (61%), NCDI (IND, 62%)	(1.00025)
4	Economic factors	2.6975
(76.85%)	Oil (87%) and Coal (69%) price, GDP p.c. (60%)	(1.00021)
5	Environmental Policy	1.9901
(82.69%)	OECD (EPS, 62%; Pub. R&D, 62%)	(1.00418)
6	Firm-Specific factors	1.3825
(86.14%)	Market cap (66%), EBIT (58%)	(1.01140)
7	Governance factors	0.9461
(88.73%)	WWGI (GOV, 27%; COR, 23%; LAW 23%)	(1.00744)

4.3. Regression Analysis

Table 3 summarizes the results of the regression analysis. Six different models are reported, based on different CAR estimation and regression models. All models exhibit R^2 values around 6.98% (average) and R^2_{adj} values around 6.92% (average), which is relatively high for studies in this area [66]. The R^2 and R^2_{adj} values for models using CAR estimation based on MM are higher by around 2% than for models based on CMR, which indicates that the MM estimation model results are more precise. The F-tests indicate a high significance for the contributions of the factors in explaining the abnormal returns for all models.

Residual diagnostics of the linear regression model reveals two problems: residuals are heteroscedastic and not normally distributed. First, the residuals exhibit a very low correlation with the factors and predicted CAR values, which indicates robust coefficient estimation. Second, the results of the Shapiro–Wilk tests indicate that the residuals are not normally distributed, which is a basic assumption of the linear regression model. This finding could be independently and robustly be reproduced with the Kolmogorov–Smirnov test. Moreover, the results of homoscedasticity tests display another problem: the residuals are heteroscedastic. This is shown using the Breusch–Pagan test with Lagrange multiplier (LM) and F-test. The Goldfeld–Quandt disagrees with the results of the other homoscedasticity tests. As the Breusch–Pagan and Goldfeld–Quandt test assume the normal distribution of residuals, which is not the case in this investigation, we chose to employ two further tests that are residual distribution-assumption free: the Fligner–Killeen and Levene test. Both of these tests support the findings of the Breusch–Pagan tests.

As the linear regression model results include several issues, and as the dependent variable (CAR) is truncated from the left side, the linear regression model does not seem an optimal choice. For robustness checks, we decided to include truncated regression models to reproduce the findings. The results based on the truncated regression models resemble the results from linear regression models. However, residual diagnostics of the truncated regression model reveals similar problems: heteroscedastic and not normally distributed residuals. For another robustness check, we chose to include heteroscedasticity robust truncated regression models (CRCH). The results of the CRCH regression models support prior findings even though they have issues with residual diagnostics. The sign of coefficients and the significance levels of Student's *t*-tests (models 1–4) and Wald's z-tests (models 5–6) are similar. As a consequence, the estimations for the coefficients of the regression models are unbiased and can be interpreted further in the discussion.

Table 3. Regression analysis results.

Model Nr. **Regression Model** **CAR Estimation Model**	**(1)** **Linear** **CMR**	**(2)** **Linear** **MM**	**(3)** **Truncated** **CMR**	**(4)** **Truncated** **MM**	**(5)** **CRCH** **CMR**	**(6)** **CRCH** **MM**
(Intercept)	36.42 *** (0.17)	27.13 *** (0.12)	35.33 *** (0.20)	25.18 *** (0.17)	35.95 *** (0.17)	26.32 *** (0.12)
Factor 1	9.29×10^{-3} (0.02)	−0.05 *** (0.01)	0.01 (0.02)	−0.07 *** (0.01	-3.09×10^{-3} (0.01)	−0.06 *** (0.01)
Factor 2	−0.18 *** (0.02)	−0.16 *** (0.01)	−0.20 *** (0.02)	−0.19 *** (0.02)	−0.17 *** (0.02)	−0.17 *** (0.01)
Factor 3	−0.30 *** (0.06)	0.06 (0.04)	−0.35 *** (0.06)	0.07 (0.05)	−0.30 *** (0.06)	0.06 (0.04)
Factor 4	−0.02 (0.06)	−0.21 *** (0.05)	−0.01 (0.07)	−0.24*** (0.06)	0.02 (0.06)	−0.15 *** (0.04)
Factor 5	−1.19 *** (0.09)	−1.44 *** (0.06)	−1.34 *** (0.10)	−1.77 *** (0.08)	−1.14 *** (0.09)	−1.33 *** (0.06)
Factor 6	−2.28 *** (0.14)	−2.24 *** (0.10)	−2.56 *** (0.15)	−2.79 *** (0.12)	−2.07 *** (0.14)	−1.99 *** (0.10)
Factor 7	0.96 *** (0.19)	−0.24 * (0.14)	1.06 *** (0.21)	−0.31 * (0.17)	0.97 *** (0.19)	−0.16 (0.13)
F-test	88.65 ***	182.98 ***	111.63 ***	269.35 ***	77.81 ***	154.19 ***
(k, n)	(7, 9706)	(7, 12,897)	(7, 9706)	(7, 12,897)	(7, 9706)	(7, 12,897)
R square (%)	5.89	8.64	6.01	9.04	5.52	6.75
R squareAdj (%)	5.84	8.59	5.96	8.99	5.47	6.70
Residual Analysis—Normal Distribution						
— Shapiro Wilk (%)	95.29 ***	96.64 ***	95.25 ***	97.17 ***	95.08 ***	96.43 ***
— Kolmogorov Smirnov (%)	36.90 ***	39.00 ***	37.21 ***	39.40 ***	37.12 ***	39.41 ***
Residual Analysis—Homoscedasticity						
— Breusch-Pagan LM	313.2 ***	302.85 ***	289.22 ***	228.06 ***	310.27 ***	298.64 ***
— Breusch-Pagan F	45.83 ***	44.28 ***	42.24 ***	33.15 ***	45.39 ***	43.65 ***
— Goldfeld-Quandt (%)	84.25	87.16	84.18	86.32	84.07	86.76
— Fligner-Killeen	18.62 ***	12.27 ***	17.93 ***	10.82 ***	18.93 ***	13.14 ***
— Levene	19.23 ***	13.43 ***	18.59 ***	11.76 ***	19.74 ***	14.32 ***
Residual Analysis—Correlation						
— with factors (%)	6.30×10^{-14}	1.62×10^{-13}	1.85	5.23	0.75	0.74
— with predictions (%)	8.78×10^{-14}	-3.35×10^{-14}	−2.65	−7.19	1.42	2.46
— with true CARs (%)	66.50	95.37	68.25	92.97	67.80	96.10

Coefficients are supported with standard errors in brackets. Coefficients and standard errors are reported in %. Moreover * symbols indicate statistical significance as follows: *** < 0.01 and 0.05 < * < 0.1.

5. Discussion

In the following, we discuss the results based on the different factors investigated and interpret the findings in the context of prior studies in the literature. Then we validate our hypothesis.

Overall, there are mixed findings on the significance and sign of cultural factors (Factor 1), investor-related factors (Factor 3), economic factors (Factor 4), and governance-related factors (Factor 7) between models based on CMR and MM CAR estimations. However, the results indicate the importance of (political) stability factors (Factor 2), policy-related factors (Factor 5), and firm-related factors (Factor 6) on an aggregated perspective. A more in depth-perspective based on a reconstruction of the analysis reveals signs, coefficients, and significance of the different independent variables, as shown in Table A3.

Economic factors, e.g., higher prices for oil and gas significantly affect green innovation returns, as previously reported by [32]. The findings for coal are mixed and not significant. Larger gross domestic products negatively affect the returns, while there are mixed findings for related per capita values. Previous studies find a positive relationship between R&D expenses and green innovation activity (measured in the number of patents) [31]. However, we do not observe that larger total R&D spending in an economy results in higher green innovation returns. As most studies before focus on the early stage of innovation, the positive relationship of rising prices for conventional (fossil) resources is obvious, because it incentivizes research on alternative technologies. For the later stage of innovation, however, competition is counterproductive for market participants, as successful green innovation commercialization takes place in a narrow win–win area caused by higher uncertainty for green innovations [2,10].

Larger values for firm-specific financial properties such as stock price, market capitalization, or earnings before interests and tax (EBIT) significantly decrease green innovation returns. Studies in the existing literature argue that larger firms are less innovative [8] and incorporate the traditional view of corporate green environmentalism and profits more in their corporate culture [3].

Cultural beliefs and values have a significant impact on the returns of green innovation. On the one hand, individualism, power distance, and uncertainty avoidance have a positive impact. On the other hand, masculinity and long-term orientation have a negative impact. The findings for indulgence are mixed. Similar findings can be found in a study on the success of green crowdfunding campaigns [17].

Governance-related factors significantly affect the returns of green innovation. Political stability and rule of law (included in the International Property Rights Index) have a positive financial effect, while control of corruption is related to a negative outcome. The Worldwide Governance Indicators are negatively related to the returns. These findings reflect common knowledge of finance such as uncertainty avoidance of investors [12].

Political factors such as the governments' attitude towards becoming greener (CTGCI) are shown to have a significant positive impact on financial outcomes. This relationship has been observed before [32]. The effects of environmental policy stringency and public R&D budgets to foster innovation are mixed and not significant in explaining the returns of green innovation. For models based on MM CAR estimates, however, environmental policy stringency is observed to have a significant negative impact on the returns, contrary to prior findings that investigated the R&D output [31].

Investor-related factors have a large explanatory power for the returns of green innovation. Investor rights (ADRI) are related to lower returns. Contrary to prior findings on the earlier stages of innovation [11], property (protection) rights (IPRI Overall) in general are positively related to returns. Interestingly, physical property protection rights are more important than the protection of intellectual property rights for the successful commercialization of green innovation. These findings can be explained by the competition paradigm mentioned before.

With regards to Hypothesis 1, we find evidence for its confirmation. Economic factors such as oil, coal and gas price, as well as investments in R&D by both corporate and government organizations provide evidence. Rising prices and investments in green R&D will increase competition in green innovation markets and thus reduce the financial performance of firms operating in these.

With regards to Hypothesis 2, we find evidence for confirmation as well. The results (Tables 3 and A3) exhibit that economic, firm-specific, cultural, governance-related, political and investor-related factors significantly impact the (financial) success of green innovation at the later stages of innovation.

6. Conclusions

6.1. Summary and Key Findings

This paper aims to complement the existing literature on the financial performance of successful corporate environmentalism and green innovation. The study extends the existing literature by research on listed (stock) companies and cross-sectoral research. Successful corporate environmentalism and green innovation are defined by innovation at the later stage meaning go-to-market, commercialization, and diffusion. The financial performance is measured by CARs at the publication of market-relevant information. The influence of different factors on financial performance was explored. As a result, we generated a better understanding of the influence of different factors that determine the financial outcome of successful green innovation (for large companies, at the later stage of innovation). The empirical results provide evidence for the assumption that higher competition leads to lower returns for green innovating firms as they are especially competition sensitive. Moreover, the results show that political, cultural, investor-related, governance, economic, and firm-specific factors significantly impact the financial performance of corporate environmentalism. Additionally, the opposing influence of factors, that benefit the earlier but harm the later stages of innovation, was observed.

6.2. Significance of This Work

This study contributed to the literature as follows. First, to the best of our knowledge, this is the first study to analyze the financial outcome of green innovation and corporate environmentalism and its determinants for large, listed companies. Second, this study extends previous works by focusing on the later stages of innovation, such as commercialization and market diffusion. Third, the results imply the harmfulness of competition for the financial success of green innovation, and at the same time lead to the first observation of opposing effects of certain factors on early and later stages of innovation in the literature. Fourth, the study generates novel, important and valuable insights for a better understanding of which factors play an important role in the underlying mechanisms of the financial success of green innovation and corporate environmentalism for large, listed companies. Our investigations lead to the following implications for both policymakers and company leaders.

6.3. Implications for Policymakers

The discussion of findings above showed that many factors in this study possess different signs for their effects. While prior studies focused on the early stages of innovation and tried to explain the R&D output, we focused on the later stages of innovation and tried to explain the financial output of corporate environmentalism. This means that factors that positively influence the outcome of early stages of innovation do not necessarily benefit the later stages of innovation. Take the prices for fossil resources such as oil and gas as an example; higher prices can incentivize companies to conduct research on novel means based on regenerative resources; however, this stimulates competition, which narrows the nonrival-strategy win–win area in which successful corporate environmentalism takes place.

Figure 4 summarizes the sign and strength of significant factors on the financial performance of green innovation that can be controlled by policymakers (directly or indirectly). On the one hand, the protection of property rights (esp. physical property rights), political stability, and rule of law as well as the governments' willingness to migrate the economy's growth trajectory to a sustainable path (CTGCI) boost the returns of green innovation. On the other hand, lower subventions for R&D, lower oil and gas prices, and a lower GDP reduce competition and thus foster the financial outcome of successful green innovation. An important observation here is that policymakers have levers that are conducive for the outcomes of earlier stages of green innovation but harmful for the later ones. Thus, governments and policymakers need to find an optimum between both stages of green innovation and balance their actions accordingly.

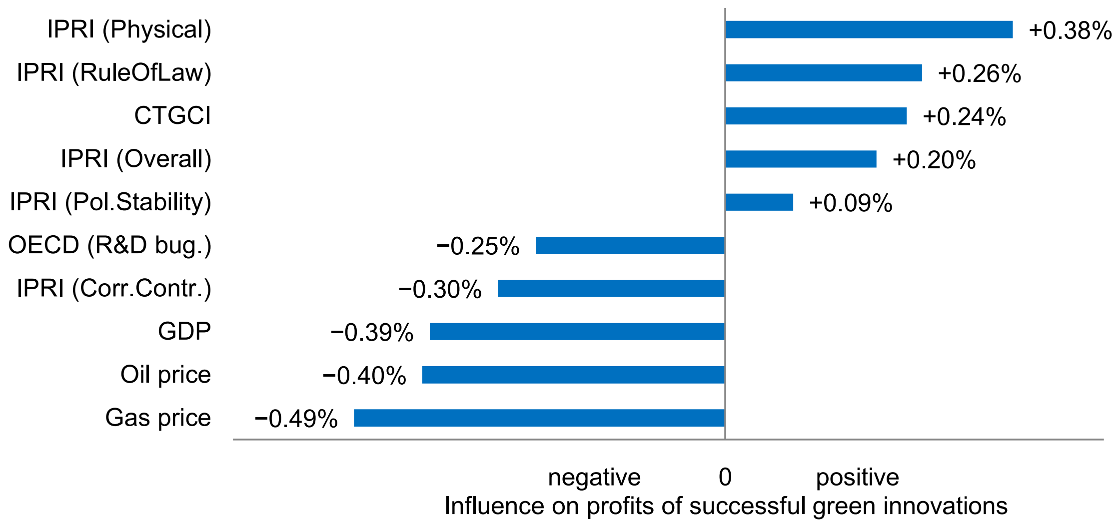

Figure 4. Impact of factors that can be controlled by policies on the success of green innovation.

6.4. Implications for Company Leaders

The findings provide evidence for the nonrival-strategy win–win areas for green innovation as discussed by [2,7]. Large, multinational companies can benefit from reallocating resources for corporate environmentalism-related activities into countries with more suitable framework conditions. Similar to the considerations for policymakers, company leaders should be aware that different stages of innovation need different framework conditions to be suitable. Thus, spatial separation and optimization of departments that conduct early research from those that commercialize later products could be a potential strategy supporting corporate environmentalism.

Figure 5 could give some guidance here. On the left side, the figure shows the empirical average returns by countries for the observation period sorted in descending order by MM estimates. On the right side, the figure shows estimations based on our CRCH regression models including the different factors discussed in this work. Countries with small sample sizes (smaller than 50) are grayed out. The dashed line highlights that the predicted model returns possess an ordinal order that resembles the empirical one.

If we consider countries with large sample sizes only, we can observe that Israel, China, Brazil, Finland, India, South Korea, and Austria count amongst the most attractive countries for the commercialization of green innovation. Moreover, countries such as Germany, Netherlands, Portugal, Thailand, Sweden, Argentina, Switzerland, and Norway count amongst the least attractive countries.

Contrary to the implications to policymakers who possess an aggregated, economic perspective, company leaders need to address their decisions more specifically to their business. This implicates that the suggested spatial separation strategy for corporate environmentalism needs to consider not only country- but also industry-, trend-, and customer-specific aspects.

6.5. Research Limitations

This study is limited to its dataset. The events reported in the articles and the measurement of performance by abnormal returns based on event study analysis are based upon assumptions that reflect the external, market-based perspective. Alternative measures of financial performance based on internal accounting for certain means of corporate environmentalism could give a clearer picture. This could be gathered through a large company survey. Moreover, a sector-specific and activity-specific investigation could support more specific and differentiated recommendations for policymakers and company leaders.

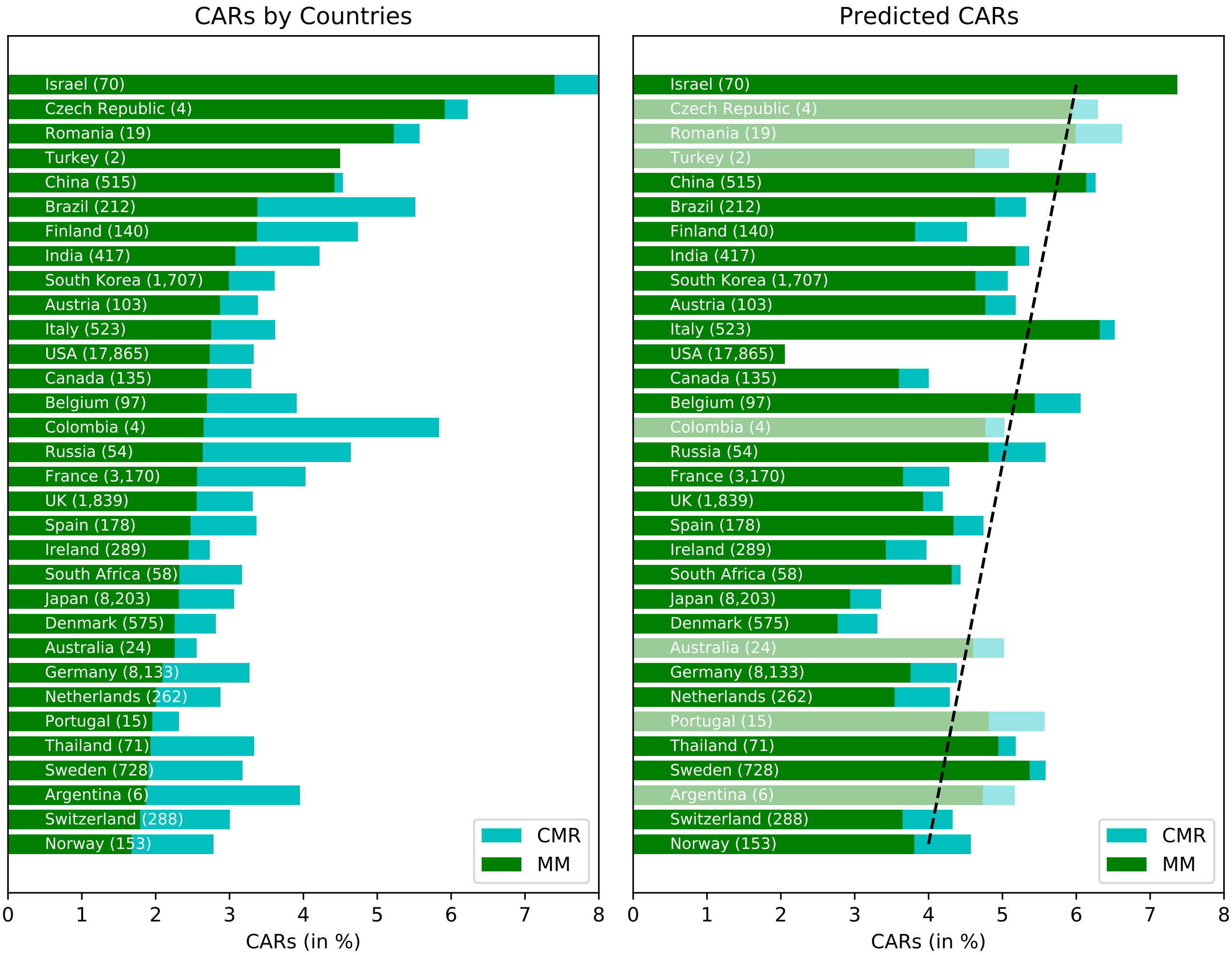

Figure 5. Regional differences in financial performance of green innovation.

6.6. Future Research

Future research could continue to elaborate on (1) the opposing effects of certain factors, (2) the long-term effect of governmental intervention, (3) a more differentiated analysis by different governmental intervention instruments, (4) the role of geographical and human capital factors, and (5) the chances that financial crises offer. First, as we found in our study, there are opposing effects of certain factors on the success at the earlier vs. the later stages of innovation. It would be interesting to further research the underlying reasons, relationships, and consequences these opposing effects offer. Second, as the governmental intervention was found to have a rather long-term effect, it would be relevant to extend this work by including temporal changes of factors such as GDP and population growth rates, taxation increase rates, and the shift of governance and cultural values for countries. Third, the understanding we generated within this study could be complemented and confirmed by a differentiated analysis by different governmental intervention instruments. This would allow government organizations to better address their intervention. Fourth, the analysis of geographical and human capital factors could be a valuable addition to this branch of research. Geographical factors could include natural aspects, such as the access to water, wind, sun, and mountains, as well as human aspects, such as urbanization rate, transportation, and energy infrastructure. Human capital factors could include the availability and quality of skilled human labor, research facilities, and education facilities such as universities. Fifth, with regards to Figure 3, it is obvious that the abnormal returns were significantly higher during the years of the financial crisis of 2008/2009. A follow-up study with more recent data could focus on the impact of the recent COVID-19 crisis on the success of corporate environmentalism and thus contribute to a better understanding of which opportunities financial and economic crises offer to green innovation.

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Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

CAR	Cumulative abnormal returns
CMR	Constant mean return model (for event study analysis)
MM	Market model (for event study analysis)
R&D	Research and development
SMEs	Small and medium-sized enterprises

Appendix A

Table A1. Descriptive statistics of dependent and independent variables.

Variable			Mean	Std	Curtosis	Skewness	q.00	q.25	q.50	q.75	q1.0	VIF
dependent	1	CAR (CMR)	0.03	0.04	1737.75	20.63	0.00	0.00	0.00	0.00	3.75	
	2	CAR (MM)	0.03	0.03	3329.71	32.45	0.00	0.00	0.00	0.00	3.82	
	3	CAR (CMR, norm)	0.37	0.17	1.06	0.72	0.00	0.03	0.04	0.05	1.36	
	4	CAR (MM, norm)	0.27	0.14	2.15	1.03	0.01	0.02	0.02	0.03	1.31	
independent	1	Oil price	91.84	25.24	−1.32	−0.53	53.05	53.05	53.05	53.05	118.71	272.05
	2	Coal price	91.45	23.64	−0.81	0.30	56.79	56.79	56.79	56.79	136.21	65.34
	3	Gas price	10.77	3.28	−0.71	0.63	2.76	3.71	6.53	6.53	16.75	346.49
	4	Stock price	86.62	155.93	15.64	3.96	2.03	2.91	3.26	3.58	938.13	2.21
	5	Market cap	6.05×10^{10}	5.01×10^{10}	1.51	1.31	3.97×10^{7}	1.76×10^{9}	2.25×10^{9}	2.51×10^{9}	2.39×10^{11}	1.76
	6	EBIT	8.17×10^{9}	8.32×10^{9}	1.37	1.38	-5.77×10^{9}	-4.67×10^{9}	-4.67×10^{9}	-4.67×10^{9}	3.50×10^{10}	2.06
	7	GDP	3.80×10^{3}	9.46×10^{2}	-7.85×10^{-1}	-2.98×10^{-1}	3.72×10^{2}	4.52×10^{2}	1.51×10^{3}	2.25×10^{3}	5.11×10^{3}	458.59
	8	GDP per capita	4.29×10^{4}	4.05×10^{3}	-4.89×10^{-1}	-3.17×10^{-1}	3.45×10^{4}	3.45×10^{4}	3.45×10^{4}	3.45×10^{4}	6.68×10^{4}	16.84
	9	CTGCI	2.85	0.42	−0.98	0.73	2.04	2.38	2.38	2.38	3.60	35.81
	10	WWGI (VOI)	1.23	0.16	−1.51	−0.07	0.99	0.99	0.99	0.99	1.45	145.73
	11	WWGI (STA)	0.80	0.24	0.54	−1.13	0.11	0.11	0.11	0.11	1.34	40.61
	12	WWGI (GOV)	1.59	0.14	−1.25	0.10	1.34	1.34	1.34	1.34	1.81	42.93
	13	WWGI (REG)	1.37	0.26	−1.58	0.29	1.02	1.02	1.02	1.02	1.86	409.21
	14	WWGI (LAW)	1.57	0.17	−1.10	0.09	1.29	1.29	1.29	1.29	1.89	201.23
	15	WWGI (COR)	1.65	0.17	−0.64	−0.57	1.31	1.31	1.31	1.31	2.07	42.54
	16	ADRI	2.79	1.47	−1.58	−0.21	0.00	1.00	1.00	1.00	5.00	1.32×10^{4}
	17	NCDI (IDV)	47.59	12.42	−1.28	0.26	11.00	35.00	35.00	35.00	68.00	2.73×10^{4}
	18	NCDI (POW)	61.18	13.34	−0.83	0.22	46.00	46.00	46.00	46.00	90.00	6.13×10^{4}
	19	NCDI (MAS)	73.65	18.77	−1.22	−0.14	43.00	43.00	43.00	43.00	95.00	2.32×10^{3}
	20	NCDI (UNC)	76.51	17.06	0.05	−0.90	35.00	35.00	35.00	35.00	94.00	7.27×10^{4}
	21	NCDI (LTO)	79.21	12.01	0.69	−1.40	21.00	36.00	51.00	51.00	88.00	1.94×10^{3}
	22	NCDI (IND)	44.38	7.75	5.14	2.49	40.00	40.00	40.00	40.00	71.00	2.68×10^{3}
	23	IPRI (Overall)	7.68	0.23	0.70	-0.11	7.18	7.18	7.18	7.18	8.30	676.40
	24	IPRI (Legal)	7.73	0.36	-0.81	-0.36	6.97	6.97	6.97	6.97	8.40	101.40
	25	IPRI (Physical)	7.10	0.28	0.91	0.33	6.40	6.40	6.40	6.40	7.88	175.03
	26	IPRI (Intellectual)	8.20	0.22	−0.10	0.28	7.80	7.80	7.80	7.80	8.74	168.47
	27	IPRI (RuleOfLaw)	7.99	0.32	−1.43	0.00	7.50	7.50	7.50	7.50	8.61	97.40
	28	IPRI (Pol.Stability)	6.64	0.38	0.00	−1.04	5.60	5.60	5.60	5.60	7.30	22.08
	29	IPRI (Corr.Contr.)	8.15	0.37	−0.53	−0.63	7.30	7.30	7.30	7.30	9.10	55.36
	30	OECD (EPS)	3.12	0.43	3.32	−1.56	1.73	1.73	1.73	1.73	3.83	inf
	31	OECD (RD bud.)	2.81	0.49	0.25	−1.07	1.58	1.58	1.58	1.58	3.37	735.45
	32	OECD (Pub. RD)	3.12	0.43	3.32	−1.56	1.73	1.73	1.73	1.73	3.83	inf

Table A2. Factor loadings, results from exploratory factor analysis.

Extracted Factors			Factor 1 (Cultural)	Factor 2 (Stability)	Factor 3 (Investor)	Factor 4 (Economic)	Factor 5 (Policy)	Factor 6 (Firm)	Factor 7 (Gover.)
Independent Variable	1	Oil price	−12.42	−16.12	−22.47	86.11	14.65	4.99	−1.49
	2	Coal price	−60.71	−9.64	−7.19	69.73	−7.09	5.53	5.48
	3	Gas price	−72.09	3.52	3.87	51.34	35.44	−0.78	−4.06
	4	Stock price	46.81	26.79	−44.01	−13.45	15.66	8.39	10.53
	5	Market cap	3.79	14.24	9.11	00.02	28.94	65.70	24.02
	6	EBIT	32.92	−4.95	7.25	−11.80	37.08	58.68	22.49
	7	GDP	−65.39	55.10	2.28	−09.26	20.66	5.34	−12.92
	8	GDP per capita	22.55	−5.17	−51.01	62.34	−1.23	2.81	−9.96
	9	CTGCI	66.36	45.23	−2.31	−02.69	−18.69	−6.50	17.01
	10	WWGI (VOI)	88.93	21.56	−35.57	09.18	4.32	0.01	−5.34
	11	WWGI (STA)	−59.02	68.82	−3.65	18.73	4.71	−0.87	−6.38
	12	WWGI (GOV)	7.88	66.62	35.69	−37.50	24.48	3.31	−27.15
	13	WWGI (REG)	87.01	43.15	4.24	04.11	−3.83	5.20	−17.55
	14	WWGI (LAW)	78.22	47.42	11.53	−08.45	16.85	2.12	−21.67
	15	WWGI (COR)	44.98	77.11	−2.54	20.20	18.91	2.46	−24.28
	16	ADRI	−52.57	−45.08	64.90	11.69	−6.68	13.51	−20.58
	17	NCDI (IDV)	−57.59	−72.50	−1.26	−22.09	15.02	−11.64	13.24
	18	NCDI (POW)	94.09	−28.93	7.34	8.90	−11.05	1.63	0.70
	19	NCDI (MAS)	−76.62	47.03	28.35	11.92	−3.27	13.58	−19.68
	20	NCDI (UNC)	−88.51	−17.93	−21.29	−23.19	18.56	−12.35	13.45
	21	NCDI (LTO)	−61.51	69.44	−31.37	−7.33	10.05	−1.72	2.72
	22	NCDI (IND)	40.80	−53.01	63.04	21.94	−19.34	14.33	−19.73
	23	IPRI (Overall)	−4.46	82.34	44.26	20.29	−13.28	−10.09	25.41
	24	IPRI (Legal)	39.37	83.77	3.14	22.89	−4.18	−7.90	11.94
	25	IPRI (Physical)	−18.49	50.41	53.33	21.01	−29.48	−5.79	35.84
	26	IPRI (Intellectual)	−45.52	59.03	51.09	0.72	−4.89	−6.42	7.67
	27	IPRI (RuleOfLaw)	86.82	30.99	−2.48	8.90	−28.82	−1.12	16.12
	28	IPRI (Pol.Stability)	−53.28	72.41	−16.56	−11.61	−7.30	−4.38	7.80
	29	IPRI (Corr.Contr.)	57.78	67.90	11.21	4.05	33.35	−14.91	1.65
	30	OECD (EPS)	47.00	−35.90	32.89	12.58	63.25	−28.75	12.07
	31	OECD (RD bud.)	−72.35	60.00	−23.77	−13.54	18.29	−1.62	−3.97
	32	OECD (Pub. RD)	47.00	−35.90	32.89	12.58	63.25	−28.75	12.07

Table A3. Reconstructed coefficients for regression analysis.

Model Nr. Regression Model CAR Estimation Model		(1) Linear CMR	(2) Linear MM	(3) Truncated CMR	(4) Truncated MM	(5) CRCH CMR	(6) CRCH MM
1	Oil price	−0.22 ***	−0.48 ***	−0.24 ***	−0.58 ***	−0.17 **	−0.40 ***
		(0.05)	(0.04)	(0.06)	(0.05)	(0.05)	(0.04)
2	Coal price	0.03	−0.13 ***	0.04	−0.16 ***	0.07	−0.08 **
		(0.04)	(0.03)	(0.05)	(0.04)	(0.04)	(0.03)
3	Gas price	−0.48 ***	−0.55 ***	−0.53 ***	−0.67 ***	−0.43 ***	−0.49 ***
		(0.05)	(0.03)	(0.05)	(0.04)	(0.05)	(0.03)
4	Stock price	−0.18 ***	−0.51 ***	−0.21***	−0.62 ***	−0.17 ***	−0.48 ***
		(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
5	Market cap	−1.66 ***	−1.97 ***	−1.88 ***	−2.45 ***	−1.51 ***	−1.75 ***
		(0.17)	(0.12)	(0.19)	(0.15)	(0.17)	(0.12)
6	EBIT	−1.57 ***	−1.89 ***	−1.77 ***	−2.34 ***	−1.44 ***	−1.69 ***
		(0.15)	(0.11)	(0.17)	(0.14)	(0.16)	(0.11)
7	GDP	−0.60 ***	−0.42 ***	−0.67 ***	−0.51 ***	−0.57 ***	−0.39 ***
		(2.5×10^{-3})	(1.57×10^{3})	(2.89×10^{-3})	(2.10×10^{-3})	(2.02×10^{-3})	(1.04×10^{-3})
8	GDP per capita	9.21×10^{-3} **	−0.18 ***	0.02 ***	−0.21 ***	0.03 ***	−0.16 ***
		(2.91×10^{-3})	(2.02×10^{-3})	(3.28×10^{-3})	(2.29×10^{-3})	(2.77×10^{-3})	(1.95×10^{-3})
9	CTGCI	0.47 ***	0.27 ***	0.53 ***	0.33 ***	0.44 ***	0.24 ***
		(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
10	WWGI (VOI)	−0.03 ***	−0.17 ***	−0.02 ***	−0.21 ***	−0.03 ***	−0.18 ***
		(2.65×10^{-3})	(1.93×10^{-3})	(3.09×10^{-3})	(2.42×10^{-3})	(2.45×10^{-3})	(1.69×10^{-3})
11	WWGI (STA)	−0.22 ***	−0.16 ***	−0.24 ***	−0.18 ***	−0.20 ***	−0.14 ***
		(5.93×10^{-3})	(4.33×10^{-3})	(6.52×10^{-3})	(5.35×10^{-3})	(6.01×10^{-3})	(4.23×10^{-3})
12	WWGI (GOV)	−0.0084 ***	-0.38 ***	−0.95 ***	−0.46 ***	−0.84 ***	−0.38 ***
		(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(9.34×10^{-3})
13	WWGI (REG)	−0.32 ***	−0.14 ***	−0.36 ***	−0.17 ***	−0.32 ***	−0.16 ***
		(2.57×10^{-3})	(1.60×10^{-3})	(2.62×10^{-3})	(1.74×10^{-3})	(2.62×10^{-3})	(1.53×10^{-3})
14	WWGI (LAW)	−0.57 ***	−0.34 ***	−0.63 ***	−0.40 ***	−0.57 ***	−0.34 ***
		(8.57×10^{-4})	(3.11×10^{-4})	(7.07×10^{-4})	(3.04×10^{-4})	(8.27×10^{-4})	(1.52×10^{-5})
15	WWGI (COR)	−0.64 ***	−0.47 ***	−0.71 ***	−0.56 ***	−0.62 ***	−0.45 ***
		(7.85×10^{-3})	(6.01×10^{-3})	(9.01×10^{-3})	(7.59×10^{-3})	(7.89×10^{-3})	(6.1×10^{-3})

Table A3. *Cont.*

Model Nr. Regression Model CAR Estimation Model		(1) Linear CMR	(2) Linear MM	(3) Truncated CMR	(4) Truncated MM	(5) CRCH CMR	(6) CRCH MM
16	ADRI	−0.55 ***	−0.04 ***	−0.62 ***	−0.06 ***	−0.52 ***	−0.01 ***
		(1.67×10^{-4})	(6.53×10^{-4})	(9.77×10^{-4})	(1.41×10^{-3})	(2.95×10^{-4})	(4.9×10^{-4})
17	NCDI (IDV)	0.34 ***	0.21 ***	0.38 ***	0.25 ***	0.32 ***	0.20 ***
		(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)
18	NCDI (POW)	0.14 ***	0.10 ***	0.15 ***	0.13 ***	0.12 ***	0.09 ***
		(0.01)	(8.74×10^{-3})	(0.01)	(0.01)	(0.01)	(8.23×10^{-3})
19	NCDI (MAS)	−0.64 ***	−0.26 ***	−0.71 ***	−0.31 ***	−0.60 ***	−0.22 ***
		(1.96×10^{-4})	(2.67×10^{-4})	(4.36×10^{-5})	(6.57×10^{-4})	(1.32×10^{-4})	(3.40×10^{-4})
20	NCDI (UNC)	0.28 ***	0.09 ***	0.31 ***	0.11 ***	0.27 ***	0.09 ***
		(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)
21	NCDI (LTO)	−0.09 ***	−0.20 ***	−0.09 ***	−0.24 ***	−0.07 ***	−0.19 ***
		(0.77×10^{-3})	(4.34×10^{-3})	(7.07×10^{-3})	(5.76×10^{-3})	(5.19×10^{-3})	(3.89×10^{-3})
22	NCDI (IND)	−0.38 ***	0.06 ***	−0.43 ***	0.07 ***	−0.37 ***	0.07 ***
		(9.82×10^{-3})	(7.67×10^{-3})	(0.01)	(0.01)	(9.06×10^{-3})	(7.05×10^{-3})
23	IPRI (Overall)	0.35 ***	0.21 ***	0.39 ***	0.26 ***	0.34 ***	0.20 ***
		(0.08)	(0.06)	(0.09)	(0.07)	(0.08)	(0.05)
24	IPRI (Legal)	0.19 ***	3.97×10^{-3}	0.21 ***	0.02	0.18 ***	-4.74×10^{-3}
		(0.05)	(0.03)	(0.05)	(0.04)	(0.05)	(0.03)
25	IPRI (Physical)	0.57 ***	0.38 ***	0.63 ***	0.47 ***	0.56 ***	0.38 ***
		(0.09)	(0.06)	(0.10)	(0.08)	(0.08)	(0.06)
26	IPRI (Intellectual)	0.01	0.15 ***	0.01	0.19 ***	0.01	0.14 ***
		(0.04)	(0.03)	(0.04)	(0.03)	(0.04)	(0.02)
27	IPRI (RuleOfLaw)	0.48 ***	0.28 ***	0.54 ***	0.35 ***	0.46 ***	0.26 ***
		(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)
28	IPRI (Pol.Stability)	0.18 ***	0.11 ***	0.20 ***	0.14 ***	0.18 ***	0.09 ***
		(7.38×10^{-3})	(5.59×10^{-3})	(8.81×10^{-3})	(7.22×10^{-3})	(7.04×10^{-3})	(5.47×10^{-3})
29	IPRI (Corr.Contr.)	−0.19 ***	−0.30 ***	−0.22 ***	−0.35 ***	−0.20 ***	−0.30 ***
		(0.04)	(0.03)	(0.05)	(0.04)	(0.04)	(0.03)
30	OECD (EPS)	−0.02	−0.27 ***	−0.03	−0.32 ***	−0.05	−0.26 ***
		(0.07)	(0.05)	(0.07)	(0.06)	(0.06)	(0.05)
31	OECD (RD bud.)	−0.26 ***	−0.26 ***	−0.29 ***	−0.32 ***	−0.24 ***	−0.25 ***
		(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(9.73×10^{-3})
32	OECD (Pub. RD)	−0.02	−0.27 ***	−0.03	−0.32 ***	−0.05	−0.26 ***
		(0.07)	(0.05)	(0.07)	(0.06)	(0.06)	(0.05)

Coefficients are supported with standard errors in brackets. Coefficients and standard errors are reported in %. Moreover * symbols indicate statistical significance as follows: *** < 0.01 < ** < 0.05. Coefficients and standard errors are reconstructed by the estimated coefficients and standard errors of the factors and the factor loadings matrix. As the independent variables are normed and decorrelated, the reconstruction is possible and valid.

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