Renewable and Sustainable Energy Reviews 151 (2021) 111570

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Green recovery packages for a post-Covid-19 world: A lesson from the collapse of Spanish wind farms in the past financial crisis

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ARTICLE INFO

Keywords:
Wind project
Spanish financial crisis
Leverage
External financing
Renewable investment
Green package

ABSTRACT

Governments are implementing massive stimulus fiscal packages to mitigate the economic crisis caused by the coronavirus disease. If policymakers want to stimulate the economy through renewable energy investments, policies must focus on financing as the key priority. This is the lesson we draw from the Spanish wind farms in the past financial crisis. Using an economic approach to the drivers of external finance within the backdrop of Spanish windfarms, this work employs a dataset of 318 projects commissioned throughout 2006–2013. The main conclusion from this study is that the financial crisis of 2008 changed the behaviour of Spanish financial institutions towards renewable projects. The pre-crisis period was a time when costly ventures were prone to a higher debt leverage. Post-crisis times, however, punished these types of projects by curbing their access to financial resources.

1. Introduction

Key multilateral organizations such as the International Energy Agency (IEA) [1] or the European Union (EU) [2] see the Covid-19 crisis as an opportunity to foster renewable energy and to favour rapid transition towards a decarbonized economy. Governments are implementing in 2020 and 2021 massive stimulus fiscal packages to mitigate the economic crisis caused by the coronavirus disease, economic and social lockdowns, and curfews. According the International Monetary Fund (IMF) [3], fiscal measures are estimated at $11 trillion globally. Around 50% of these policies are public spending and forgone income, directly impacting on government budgets and the remaining is financial support to limit bankruptcies. The Group of Twenty (G20) economies are implementing measures standing at 6% of GDP, higher than during the financial crisis of 2008–2010. The idea of the IEA or EU is to use part of these additional resources to finance clean energy projects.

The other side of these policies is the negative impact on public debt and, potentially, on financial stability in the coming years. The IMF [3] estimates that gross public debt of advanced economies will surpass 130% of GDP in 2021. At a global level, debt will surpass 100% of world GDP in 2021. Do this fiscal policy and level of public debt represent a systemic risk for future financial stability? This is a question that has no simple answer [4]. points out that "should the ongoing economic contraction last longer or be deeper than currently expected, the resulting tightening of financial conditions may be amplified by these vulnerabilities, causing more instability or even a financial crisis." The IMF [5] explicitly mentions that "other financial system vulnerabilities may be crystallized by the Covid-19 pandemic. High levels of debt may become unmanageable for some borrowers, and the losses resulting from insolvencies could test bank resilience in some countries." Financial instability in peripheral and emerging markets could be one of the outcomes of the Covid-19 Crisis.

In this context of uncertainty, using Spanish wind farms data, this study highlights that a drastic change in financial conditions can significantly reduce investment in renewable energy. The crisis of 2008–2009 had a large impact on Spanish financial institutions, changing their perception of risk and reducing the financing of renewable projects. In 2008 Spain was one the leading countries in terms of solar and wind investment (5 GW per year) and in 2013 this was close to zero. If policymakers are to implement a green recovery through renewable projects, policies must focus on financing as the key priority.

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https://doi.org/10.1016/j.rser.2021.111570
Received 16 July 2020; Received in revised form 28 June 2021; Accepted 4 August 2021
Available online 13 August 2021

List of abbreviations

LCOE	Levelized Cost of Electricity in euros per MWh
WACC	Weighted Average Cost of Capital in percentage points
NVP	Net Present Value in euros
PPA	Power Purchase Agreements
CAPEX	Capital cost in euros per MW
OPEX	Operating costs in euros MWh
SIZE	Size of the project in MW
LEV	Leverage in percentage points

In fact, insufficient financing for renewable technology is perceived as one of the main obstacles to a rapid decarbonization of the energy system. Fig. 1 shows that renewable energy investment in nominal terms at a global level has been relatively stagnant since 2010.

An essential condition to keep global warming below 2 °C degrees is the deployment of renewable energy at an unprecedent scale. According to bp [6], the share of renewable energy ought to shoot from the 4% of the world's primary energy in 2017 to 30% in 2040 to be consistent with Paris Agreement targets. In this context, financing is a critical component for the competitiveness of clean and renewables technologies, in particular wind and solar projects. In general terms, renewables are characterized by extremely low marginal costs and high initial capital costs. The resulting atypical cost structure makes it hard to follow the traditional text-book approach based on increasing marginal costs. Negligible marginal cost of solar and wind technologies brings the average total cost per MWh generated as the relevant variable. The Levelized Cost of Electricity (LCOE) is a proxy of the average total cost per MWh generated, is commonly utilised to interpret competitiveness in power technologies [7]. Therefore, the LCOE becomes the standard key metric for assessing the cost of the renewable energy in power generation. LCOE is the discounted total of costs generated throughout the lifespan of the project over the discounted total production of electricity. The discount rate has a significant impact on the LCOE and, therefore, on the economic profitability of renewable projects, as suggested by [8]. Energy firms use the Weighted Average Cost of Capital (WACC) to determine the LCOE as well as the Net Present Value (NPV) of their clean technology investments [9]. WACC represents the weighted average of internal and external financial costs. Financial debt is usually less costly than equity given that it involves lower risk. Financial debt claims are preferential if a firm goes bankrupt and is eventually liquidated which explains why debt is cheaper than equity. Consequently, firms incurring higher debt generally have a higher cost competitiveness accompanied by a lower WACC and LCOE.

In our opinion, the LCOE is not a good instrument to explain how external financing may be obtained. Indeed, LCOE represents a simple mathematical response to WACC: the higher the WACC, the higher the LCOE and vice versa. But WACC is also a function of the project leverage. This means that the assessing the LCOE of renewable ventures can only be done after setting a financial framework, and the same applies to its cost competitiveness.

The aim of this paper is to emphasise the potential risk that financial instability represents for renewable investments and, therefore, a rapid energy transition. To this end, we use an econometric approach to elucidate the external financing drivers of clean energy investments, particularly those involving wind energy. We use granular data for wind projects commissioned in 2006–2013 in Spain. This study focuses on the relationship between economic and technical variables and the access of those projects external financing. We focus on the following variables: debt leverage, capital and operational costs, capacity factor -or load factor-, and the size of the project.[1] It is important to make clear from the beginning that our econometric approach is limited by the information of the database. As [10] shows, there are many economic and technical aspects could impact on the financial conditions of renewable energy. That paper cites 14 different critical issues, including priority of dispatch, regulatory risk, political risk, long-term power purchase agreements, connection to grid and supportive financial institutions (among others). Our data set does not include information on all these aspects.

The rest of the paper proceeds according to the following structure: Section 2 focuses on previous academic research on this topic, Section 3 describes the data used in this study and the methodology, Section 4 discusses the empirical results and, finally, concluding remarks are in Section 5.

2. Literature review

Interest in financial leverage and firm decision-making dates to the seminal work by [11]. This is a key analysis because Modigliani and Miller presented the widely known 'irrelevance' thesis. This thesis states that a firm's capital structure is irrelevant. This irrelevance proposition holds under textbook conditions, specifically absence of transaction costs, no tax subsidies on interest payments, and with the same interest rate on borrowing by individuals and firms. As a result, the value of the company is independent of its leverage. New approaches to the financial structure of the company has been put forth since 1958, including theories based on agency costs [12], asymmetric information and signalling [13], static trade-off and pecking order theories [14] and transaction costs [15]. These theories, which consider many different determinants for the leverage of a company, have been explored subsequently in empirical analysis. In particular trade-off and pecking order theories generate different practical implications that are a guide to understand the factors of behind the leverage of a company and their expected effect. These factors can be grouped into four large groups: firm-specific, industry-specific, tax-related factors, and macroeconomic factors. [16, 17], and [18] analyse these theories using company data. It is worth mentioning that most of empirical studies on this topic tend to focus on listed corporations [19]. There are only a few applied studies that explore this topic using a set of renewable energy companies or capital-intensive industries.

[20] empirically examines the effects of uncertainty on firms' leverage decisions, using a set of UK energy firms. The results suggest that uncertainty in macroeconomic conditions and uncertainty in the business activity of the company have a significant negative impact on leverage ratios [21]. deals with the financial aspects of wind power generation companies in Latvia. This study suggests that there is a negative relationship between leverage and profitability. The same study, on the contrary, finds that leverage is positively correlated with economic activity, the value of the assets used as collateral, and size of the firms.

Within the context of renewable energy and for emerging economies [22], examines the fact that financing clean projects requires access to material resources, by many parties, in different points of the project life cycles [23]. makes a relevant proposition and presents a new financing instrument, called hybrid bond to build renewable energy projects [24]. reviews the standard tools used to finance clean energy in emerging economies and focuses on new financial instruments. In the case of the U.S, [25], explores emerging private financing opportunities within the context of historical financing instruments. In the context of the oil-rich

[1] The capacity factor is defined in this paper as the expected electrical generation over a year compared to the maximum possible electrical generation over a year.

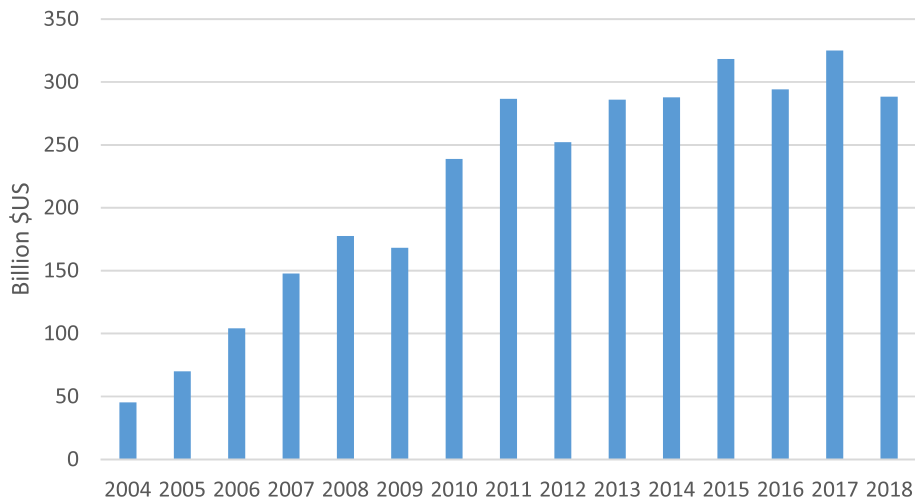

Fig. 1. Nominal investments in renewable energy, excluding large hydro.
Source: IRENA (International Renewable Energy Agency).

economies of the Middle East [26], suggests that institutional and technical barriers, combined with subsidies to fossil fuels represent a barrier for the development of renewable projects. The same study proposes power purchase agreements to minimize the risk associated with market price fluctuations while the same time favours cost-efficient auctions [27]. finds that the public sector may have a role as a direct investor in renewable projects. The reason is that the public sector tends to invest in technologies that have a higher level of risk [28]. focuses on risk mitigation as a positive strategy for project developers and investors, simultaneously. In the European context [29], study the critical role of project finance for renewable projects in Germany and [30] focus on the same topic, but in the Philippines. In the case of emerging economies [31], proposes the need of multilateral financial instruments to reduce the risk of renewables investments. Using an empirical approach [32], analyses the differences between the costs of debt of renewable firms and conventional energy firms. Finally [10], thoroughly analyses renewable energy financing in the Arabic peninsula. The relationship between renewable energy and its financing is a relative novel topic [33]. conduct a bibliometric analysis on this topic, finding that in 2018 there are only 450 articles that covers the financing of renewable energy from very different perspectives including public support in European countries, financing via private financial intermediaries, investment opportunities by private investors, or clean development mechanisms.

This empirical study examines leverage determinants for 318 wind projects in Spain commissioned in 2006–2013. In our opinion, the emphasis on individual renewable projects is what makes our analysis new and interesting. As far as we know, this is the first work to analyse how debt leverage relates with the economic and technical components of individual renewable projects. In addition, the Spanish experience is a valid lesson for those countries that are going to use green energy packeges as tool to accelerate the economic recovery after the Covid-19 crisis.

3. Description of the data and methodology

3.1. Data

Our dataset includes financial and operational information on 318 onshore wind projects implemented in Spain during the period 2006–2013. Bloomberg New Energy Finance (BNEF) provides information on leverage, capacity factor, location, CAPEX, and number of projects [34]. The database is the same one used by [35]. The total installed capacity of the projects included in the database is 10.7 GW (GW). This represents 83% of the total wind installed capacity during 2006–2013, according to BP [36]. The database does not include projects with an installed capacity below 15 MW (MW). Fig. 2 shows additional new capacity in wind technology in 2006–2017 in Spain.[2] The dotted line represents the start of the crisis in Spain, a key year for our analysis.

In addition to BNEF data, the database contains additional information. For each project, the database reports the year in which the project was commissioned, the capital cost in €/MW, the operational cost in €/MWh, the size in MW, the leverage (ratio of debt relative to total capital expenditure), the LCOE in €/MWh, the WACC and the capacity factor (CAPF). Capital and operating costs are in constant euros, with 2013 as the base year. Additionally, the Comision Nacional de la Competencia (the regulatory body for electricity markets) provides data on generation and financial support to renewable facilities [37].

The WACC for each project is taken directly from [35]. In particular, the WACC is the weighted sum of two elements: a) the cost of the equity which is assumed to be 8 % in real terms and, b) the cost of external financing, which is the real interest rate of long-term loans to non-financial corporations for each year provided by [38]. Regarding the financial conditions, we assume that all debt is structured as amortized loans in which there are equal payments over the maturity of the loan.

Table 1 presents some descriptive statistics. The leverage is, on average, equal to 47%, but it ranges from a minimum of 10% to a maximum of 85%. The size of the project -on average-is 34 MW, with a minimum of 16 MW and a maximum of 94 MW. The average capital costs are €1.5 million/MW, and there is limited variability across projects. The average operating costs is €18/MWh, but it has more pronounced variability. The WACC is 6% on average, while the capacity factor ranges from 6% to 40%.

In this study we also explore, to what extent, cost-competitive projects have access to higher debt. To that end, we use LCOE as a proxy of economic competitiveness. We use €83/MWh as a cut-off to differentiate economically 'attractive' from 'unattractive' projects.[3] The reason is that €83/MWh represents the average feed-in tariff in 2006–2013. In addition, it is also the average LCOE for Spanish wind projects commissioned in that period. Using this threshold, we get two different sets or subsamples: a first set with projects with a LCOE below €83/MWh

[2] For each year we show the net installed capacity addtion of wind energy in MW.

[3] We use the labels "attractive" and "unattractive" simply to differentiate projects with an estimated LCOE lower or higher than the average feed-in tariff.

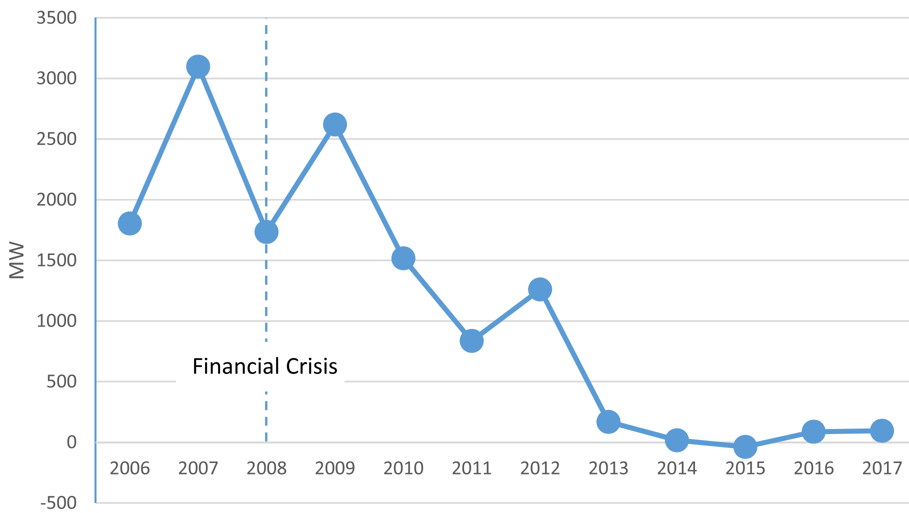

Fig. 2. Additional installed wind capacity.
Source: BP and authors' calculations.

Table 1
Descriptive statistics.

	Units	Mean	Standard deviation	Maximum	Minimum
Capital cost	€/MW	1,490,700	93,358	1,691,939	1,214,400
Operating cost	€/MWh	18	5	42	10
Size	MW	34	12	94	16
Leverage	%	47	16	85	9.9
LCOE	€/MWh	84	26	193	36
WACC	%	6	1	8	4
Capacity factor	%	19	6	40	6

Source: Bean et al. [35] and authors' calculations.

and a second set with projects with a LCOE above 83€/MWh. The first set has 186 attractive projects and the second has 132 unattractive projects. In addition to these two subsamples, two additional subsamples are defined. One with projects commissioned during 2006–08 and another one with projects commissioned during the recession, 2009–2013. The idea here is to understand if the financial drivers that determine the leverage changed during the financial crisis. There are 191 and 127 projects in the two subsamples, respectively. Table 2 reports descriptive statistics of projects with a LCOE above and below 83€/MWh and of those initiated before and during the recessionary period.

Table 2 shows that there are significant disparities between attractive and unattractive projects. Leverage and capacity factors are higher in attractive projects, while operating costs and LCOE are lower in unattractive projects. There are no significant changes instead in projects' characteristics before and during the recession. Fig. 3 examines the four different types of project that we study.[4]

Table 2
Descriptive statistics of subsamples (mean values).

	Whole sample	LCOE below €83/MWh	LCOE above €83/MWh	Before recession 2006-08	Recession 2009–2013
Projects	Number	186	132	191	127
Capital cost	€/MW	1,485,341	1,498,252	1,470,481	1,521,108
Operational cost	€/MWh	15	22	17	18
Size	MW	33	35	32	36
Leverage	%	57	33	48	46
LCOE	€/MWh	67	108	81	88
WACC	%	5	7	6	6
Capacity factorv	%	23	14	20	18

Source: Bean et al. [35] and authors' calculations.

3.2. Methods

We use a multiple regression method to empirically assess the relationship between the dependent and independent variables for our sample. Recall that our database is comprised of a set of 318 individual projects commissioned in different years and that there is only one observation per project. The dataset is, thus, not a proper panel, so we cannot use panel econometric methods.

We estimate a set of leverage equations by ordinary least squares.[5] To allow for the possibility of heteroscedasticity, which is likely given the nature of our data, we compute heteroscedasticity-robust standard errors. The regression model is the following:

$$ln(LEV)_i = \beta_0 + \beta_1 ln(SIZE)_i + \beta_2 ln(CAPF)_i + \beta_3 ln(OPEX)_i + \beta_4 ln(CAPEX)_i + u_i \quad (1)$$

for $i = 1, \ldots, 318$ and where u is the error term. All variables are expressed in natural logarithms. The β coefficients account for the partial effect of the explanatory variable considered on leverage. The ratio between estimated coefficient and its standard error informs us about the statistical significance of such an effect: if the t-statistic is above 2, as a rule of thumb we can say that the regressor is a significant explanator of leverage, other factors held constant. In addition to considering the statistical significance of individual explanatory variables, we would like to check the overall statistical performance of the regression. This is typically done by means of the R^2 indicator, adjusted for the presence of an intercept in the model: the closer the index is to 1, the better the overall performance. More rigorously, we can carry out a formal test of

[4] Each circle shows the number of projects in that subset. The title of this chart has been changed relative to the original source.

[5] To estimate the parameters of (1) we use the ordinary least squares. This method obtains the estimated parameters as a solution of the minimization of the sum of the squared residuals, given by the difference between the observed and predicted values of the dependent variable, u_i. In our case, the dependent variable is Leverage and the explanatory variables are reported on the right-hand side of (1).

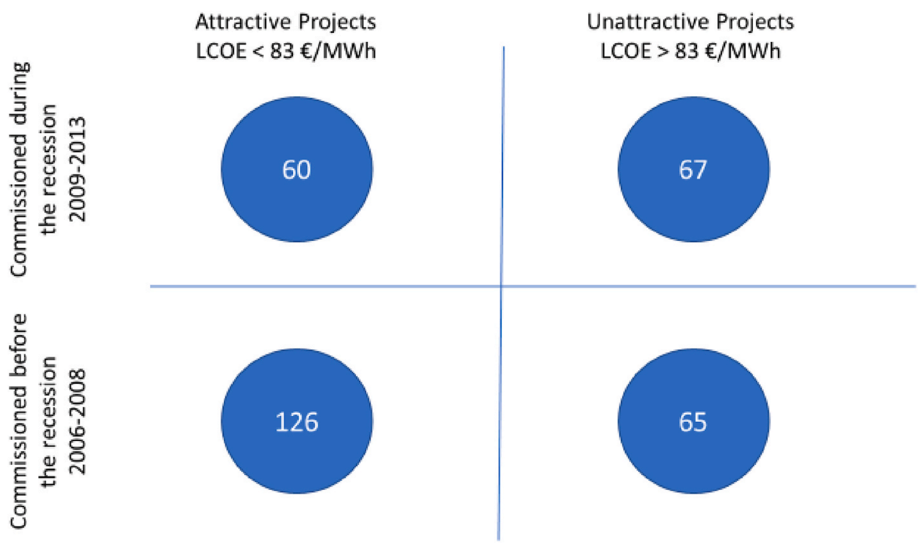

Fig. 3. Number of projects.
Source: [35] and authors' calculations.

significance of all β coefficients (except for the intercept): if we cannot reject the hypothesis that they are jointly equal to zero, then the overall regression is statistically meaningless. This is the F-test and Table 3 shows the F statistics together with the *P*-value. If this value is smaller than 0.05 (the confidence level α is taken to be equal to 5%), then the null hypothesis is rejected, and the regression is statistically meaningful. We provide the outcome of a few additional tests on the goodness of fit with regard to the specification of the model: (i) the Ramsey's RESET test, which is a general test of model misspecification; (ii) the Lagrange Multiplier (LM) test of residual heteroscedasticity; (iii) the Bera-Jarque test of normality of residuals.[6]

4. Results

It is undoubtable that an array of economic and technical factors attracts banks or lenders to projects. What are they? How do they work? Using an econometric approach, this work attempts to improve our understanding of these factors. To this end, we run a series of econometric regressions based on expression (1).[7] Let us note that the work here focuses on individual projects rather than firms and our data is restricted to those pertaining to the variables employed within the study.

Before explaining the results, we highlight that the findings of this study are shaped by the energy policy, power market conditions, cost of the technologies, and regulation for renewable projects of Spain in 2006–2013. Logically, these factors determine the projects effectively commissioned in that period and have an impact on the lessons learnt from this econometric study. However, we think they provide useful insights and relevant lesson for a post-Covid-19 world.

Table 3 consists of three different sets of regressions and their corresponding estimation results. The entire the dataset is used for the first group (column 1). The second group (columns 2 and 3) contrasts projects with LCOE lower and higher than 83€/MW (i.e., attractive vs unattractive projects). The third and final groups (columns 4 and 5) discriminates two time intervals of: 2006–2008 and 2009–2013.

We point out that statistical tests indicate that the regression models do not show signs of misspecification.[8] In addition, the performance of the regression is more than adequate, judging from the adjusted R^2.

Before turning to the empirical results, it must be noted that the debt represents the outcome of dealings among lenders (banks) and borrowers (project developers). Throughout these negotiations, banks make an effort to minimize risks by giving the possibility of dispensing more debt to the best projects. (i.e., those consisting of small amounts of capital and expenses that thereby thrust the likelihood of achieving higher profits) and minimising the amount of debt offered to 'worse' projects. However, those who develop the projects follow the opposite strategy. For instance, developers of 'worse' projects try to put equity at a minimum while maximizing the debt to reduce their own risk. This implies that economic theory does not yield a priori concerning the sing of the regression coefficient, it could be positive -if developers have the upper hand- or negative -if banks have the upper hand-.

Regression one (column 1) shows that the cost of a renewable energy project explains its leverage. This implies that financial institutions or banks have the upper hand in the negotiating process, not the developers of wind farms. This result is not a surprise. Banks tend to finance more generously those projects that have lower costs to minimize their own risk, in other words, they tend to grant financial aid to these endeavours.

It is important to highlight that an expensive project, in terms in capital and operating costs, does not imply automatically that the project is less competitive. The competitiveness of a project is a combination of the cost per MWh generated, as assessed by the LCOE, and the revenues from those MWh generated, which depend on market conditions and regulations.

However, the size and, more importantly, the capacity factor of the project have no statistically significant impact. Capacity factor measures productivity in terms of electricity generated by renewable technologies, impacting directly on the competitiveness of the project. Our results signal that higher debt leverage does not appear to correlate with more productive projects. This surprising result may follow as endeavours of this kind -characterised by a long period of maturity and long-

[6] The null hypothesis of these tests is, respectively, absence of misspecification, absence of heteroskedasticity, and non-normality of residuals.

[7] We have estimated a set of alternative regressions, but we opted for this set of independent variables because they provide an economic interpretation to the econometric results. A variable named AGE – the year in which the project was commissioned – did not generally prove to be statistically significant. Although suggested to be potentially relevant by the literature surveyed in Section 2, there was too little variability in the series for the variable to possess explanatory power. No information was available about the ownership of the projects in the dataset.

[8] The LM test in columns 2 and 3 points to some residual heteroscedasticity.

Table 3
Estimation results for the determinants of leverage in Spanish wind projects.

	(1) Whole sample	(2) LCOE below €83/MWh	(3) LCOE above €83/MWh	(4) Before recession 2006-08	(5) Recession period 2009–2013
constant	15.36***	15.79***	14.45***	−2.54	19.75***
	(11.82)	(9.66)	(6.04)	(−0.86)	(9.04)
ln(SIZE)	0.01	0.01	0.01	0.01	0.00
	(1.04)	(1.35)	(0.19)	(1.06)	(−0.10)
ln(CAPF)	0.03	0.25	−0.40**	0.19	1.13
	(0.18)	(0.98)	(−2.71)	(1.36)	(1.49)
ln(OPEX)	−1.44***	−1.10***	−1.98***	−1.27***	−0.09
	(−6.13)	(−3.35)	(−12.11)	(−7.24)	(−0.10)
ln(CAPEX)	−0.85***	−0.92***	−0.73***	0.40**	−1.29***
	(−10.76)	(−11.21)	(−4.28)	(2.04)	(−5.56)
Adjusted R^2	0.96	0.91	0.91	0.99	0.94
F test	2056.83	471.54	340.57	5703.66	488.25
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Reset test	9.73	7.05	4.54	171.82	3.57
	[0.00]	[0.01]	[0.03]	[0.00]	[0.00]
LM test for heteroskedasticity	5.65	0.77	2.11	12.654	5.61
	[0.02]	[0.38]	[0.15]	[0.00]	[0.02]
Bera-Jarque test	93987.6	30382.1	28642.2	323.853	13156.6
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
No. obs.	318	186	132	191	127

Note: T-ratios are based on robust standard errors in round brackets. *P*-values in square brackets. Three asterisks, two asterisks, and one asterisk denote significance at 1 %, 5 %, and 10 % level, respectively.

term revenues-are prone to regulatory changes. Within this context, long-term revenues are hardly predictable. Moreover, even though financiers grasp the relevant of costs they are less acquainted with the revenue volatility associated with wind power generation. Banks generally focus more on costs to decide on projected risk given the huge fluctuation between forecasted capacity factors, expected returns and turnouts.

To summarize, capital and operational costs of a project are the main determinants of the level of debt of a renewable project, but the capacity factor and power generation have a minor relevance. Banks would focus on capital and operational costs to assess the risk of the project and, therefore, to determine the level of debt.

The figures in columns 2 and 3 look at possible LCOE dissimilarities in attractive versus unattractive ventures. The coefficient of the operating and capital expenses of these regressions are negative and significant. This implies that lower-cost projects gain entry into a greater debt. There is no qualitative difference with column 1. The role of capacity factor represents the main difference between these two categories of ventures. For unattractive ones the coefficient of the capacity factor in projects having a LCOE over €83/MWh-is negative and significant. This implies that those projects that appear to be less productive in terms of power generation only gain entry into a lower level of debt. By contrast, this variable does not seem to be statistically relevant for attractive projects. This result suggests that banks penalize those unattractive projects that have lower power generation and potentially lower revenues. This is, again, a bank strategy to minimize their own risk for this type of projects.

Columns 4 and 5 examines pre- and post-financial crisis differences. The significant findings presented in these columns reveal a shift in the parameter linked to capital cost. This is a key finding in this econometric analysis, given the aim of this study. The reason is that prior to the crisis, the leverage and the capital cost were correlated positively and significantly. This suggests more expensive projects managed to access to higher debt. Before the crisis, the banking system were prone to over-finance more expensive projects, resulting in a higher leverage ratio. However, the sign of this parameter becomes negative during 2009–2013. Banks made it harder to access financing; hence, the more expensive the project, the lower debt. An explanation is that banks slackened their view of renewable project risk throughout the period in 2006–2008. This implies that in 2009–2013 projects with lower capital costs faced a less difficult financial environment. This change in the behaviour of the financial system is the cornerstone result in this analysis.

There is no doubt about the repercussion of the crisis on the financial system and loans to the private sector. Even though the European Central Bank relaxed financial conditions, it did little to downplay the significant increase in the Spanish sovereign risk premium, which increased the cost of debt and pushed down private sector financing [39]. reveals that enterprises in Italy, Spain, and Portugal suffered an average increased in financial costs of between 70 and 120 basis points consequent to the negative spill overs of the sovereign debt crisis in 2010–2012. Yet German firms collected a 40- basis points discount [40]. reports extraordinary loans to the Spanish private sector plummeted by around 6% from December 2008 to the same month in 2011.[9]

In 2020 and 2021, a significant number of countries and regions, including the European Union, put in place green recovery packages to stimulate the economy and accelerate the energy transition. Column 4 and 5 show that a crisis changed the behaviour of the Spanish financial system towards renewable energy. In this case, there was a contraction in the access to external financing and more expensive projects were penalized. Most likely the financial crisis led to a change in perception of risk associated to clean technologies. Looking at the future, the Covid-19 crisis could have an impact on the financial system reducing the leverage of renewable projects and, therefore, impacting on their feasibility and competitiveness. Policymakers should put in place early warning systems to detect a change in banks and other financial institutions regarding clean energies. The aim of the article is to shed light on a potential issue that, so far, seems to be out of the radar of policymakers. The article is based on a past experience, but it could point out a potential problem in the future.

[9] Some financial institutions disappeared during the recession [41]. In 2007 Spain had 45 savings banks and by the end of 2012 the number had dropped to 13. The Bank of Spain and the Fund for the Orderly Restructuring of the Banking Sector bailed out seven savings banks, and four of them were nationalized.

5. Conclusions

Some multilateral organizations and governments are developing green fiscal packages to stimulate the economy after the Covid-19 crisis of 2020. These efforts may not generate positive results in the coming years if the financial conditions for renewable projects deteriorate. This is the Spanish lesson from the financial crisis of 2008–2009. Given this lesson, policymakers should put in place policies to make sure that the Covid-19 crisis and the resulting economic crisis do not change the behaviour of financial institutions towards renewable energy projects. If the financial conditions for renewable projects worsens because of the economic crisis, green stimulus packages could be infective in terms of renewable deployment and economic recovery.

Credit author statement

Jorge Blazquez: Conceptualization, Data curation, Writing of the original draft, Writing – review & editing. Marzio Galeotti: Methodology, Software, Formal analysis, Writing – review & editing. J.M. Martin-Moreno: Writing of the original draft, Investigation, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

Martín-Moreno would like to acknowledge the financial support of the Spanish Government and Feder through grant RTI2018-093365-B-I00.

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