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RENEWABLE ENERGY POLICIES AND CROSS-BORDER INVESTMENT: EVIDENCE FROM M&A IN SOLAR AND WIND ENERGY[1]

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ABSTRACT

The study assesses the role of feed-in tariffs (FITs) and renewable energy certificates (RECs) in creating incentives for cross-border investments and for investments in particular technological portfolios via M&A. The analysis explores the dataset on M&As in alternative energy sources worldwide over 2005-2011. The results suggests that FITs encourage more diversified M&A than RECs. With respect to foreign investment, the study finds a linear relationship between FITs and cross-border M&As in the wind energy sector, but an inverted U-shaped relationship in the solar energy sector. One possible explanation for the latter may lie in reduced policy credibility due to the public finance implications of 'generous' FITs. Another possible explanation for this finding concerns the use of high solar FITs by countries whose natural conditions provide little comparative advantage in solar energy, suggesting that low profitability and limited potential of solar energy in those countries might have deterred the entry of foreign investors.

JEL codes: G34, Q42, Q48

Keywords: energy portfolio, foreign direct investment, M&A, renewable energy policies, solar and wind energy

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1. INTRODUCTION AND KEY RESULTS

Mitigating climate change will require increased investment in renewable energy technologies. Since first-best policies penalising greenhouse gas emissions, such as carbon taxes, are not sufficiently stringent to meet mitigation objectives, many governments are using positive support measures to increase private investment in the development of new energy sources. Examples of such policies are feed-in tariffs (FITs) and renewable energy certificates (RECs). Such policies either provide a price incentive (FITs) or guarantee a share of the market (RECs) for renewable energies in the electricity supply mix.

They may also have an effect on merger and acquisition activity (M&A) in the sector. The rapid growth of this form of private investment in the new energy sector during the last few years can provide new evidence on the effects of renewable energy policies on private investment. This paper will assess the role of renewable energy policies in creating incentives for cross-border investments and for investments in particular technological portfolios via M&A.

The role of FITs and RECs in inducing M&As in this sector may be important from several perspectives. Recent studies on M&A stress the importance of the dynamic effects of mergers (e.g., Veugelers, 2012), arguing that some M&As can deliver social gains through innovation. If so, technologically motivated M&As may turn out to be an important channel for innovation in renewable energy technologies, thus alleviating the ‘double market failure’ arising with respect to these innovations (Jaffe et al., 2005).[2] Furthermore, there are market failures in the seed and early stage financing of “new energy” ventures. In particular, the recent literature on financing of environmental innovations argues that the absence of an established exit mechanism for start-ups[3] in the new energy sector might lead to the underfinancing of more radical innovations. Since the development of energy technologies is both very risky[4] and capital intensive, the financing of emerging renewable technologies may not benefit from venture capital investment. In addition, market failures in the capital market may deter firms from scaling up, and an acquisition by an industrial company having better access to financing can alleviate this financing problem (Gillingham and Sweeney, 2012; Ghosh and Nanda, 2010; Criscuolo and Menon, 2014).

In comparison to within-country M&A activity, the effect of cross-border M&As on international diffusion of technologies may generate additional social benefits in the area of renewable generation since both target and acquirer countries will gain from increased international diffusion of mitigation technologies. All countries stand to benefit from increased mitigation, irrespective of the location in which it takes place, because in the case of renewable energy there are both economic and environmental cross-border spillovers. These can be significant since cross-border M&As account for 80% of the total foreign direct investment of industrialised countries (Conn et al., 2005). However, most of the environmental economics literature has not specifically looked at Foreign Direct Investment (FDI) and at the difference between foreign and domestic investment in the adoption and diffusion of clean technologies.

In fact, the role of M&As in the new energy sector is not clear-cut. While having potential positive effects – such as those on innovation and finance described above – M&As also impose transaction costs. More importantly, they may generate negative externalities if they reduce competition in the market. Therefore, there is a need to be careful in drawing policy implications in this area. Yet, understanding the relationship between renewable energy policies and the M&A process in this sector sheds light on the role of policy design aspects – including technology specificity, generosity, and sustainability – for achieving a good investment climate in this sector that could contribute to the diffusion of these technologies.

To our knowledge, this research topic has not yet been explored in the existing empirical literature. The current paper aims to contribute to the literature by investigating M&As in the new energy sector. More specifically, the aim of this paper is i) to describe the pattern of M&A in the renewable electricity area; ii) to investigate how this pattern is affected by renewable energy policies applied in the host country, in particular, how the generosity of new energy policies attracts foreign acquirers and how it affects the diversification of the country's renewable energy portfolio. Given the trade-offs that arise because of technological uncertainty and public budget constraints, a good understanding of the reasons and drivers of M&As in the new energy field can help shape the regulatory environment in such a way that could boost private investment in this sector.

The empirical analysis draws upon the Bloomberg New Energy Finance data (BNEF, 2013a) on M&A activity, covering acquisition deals in the new energy sector world-wide over the period 2005-2012.[5] The dataset on renewable electricity sectors contains information on 1 231 acquisition deal records in six renewable electricity sectors, namely solar, wind, biomass and waste, small scale hydro, marine, and geothermal energy.

This dataset has been linked to country-level data on policies. In particular, a new harmonised international database (OECD-EPAU, 2013), including information on the level of feed-in-tariffs (FITs) and the volume of renewal energy certificates (RECs) adopted by each country, is exploited to investigate how these renewable energy policies affect M&As. The deal-level analysis of the relationship of renewable energy policies on M&A activity in the power sector (namely, FIT and REC policies for solar and wind energy over the period 2005-2011[6]) provides new evidence on potential effects of these instruments.

The analysis exploits the difference between cross-border acquisitions and domestic acquisitions. Based on the literature, cross-border acquisitions are associated with higher costs, e.g., because of longer and more complex integration and adaptation processes. However, since the pool of international acquirers is larger and more diverse than that of domestic acquirers, the probability that a better match could be achieved by an international deal is also higher. Therefore, similarly to foreign investors in general, foreign acquirers will be more sensitive to additional risks that may arise on the policy side; but if risks are low, the response in the increased supply of foreign bidders may be relatively higher than that of domestic bidders.

By analysing the relationship between FIT and REC policy generosity and the likelihood of cross-border M&A in the solar and wind sector, this paper finds a linear relationship between FITs and cross-border M&As in the wind sector, but an inverted U-shaped relationship in the solar energy sector: while a moderate FIT increases cross-border M&A, a FIT which is too "generous" may actually decrease it. One possible explanation for the latter may lie in reduced policy credibility due to the public finance implications of FITs. If FITs are too generous they may not be seen as financially sustainable. This may affect foreign acquirers disproportionately since they generally face greater information asymmetry and uncertainty about market conditions in the target's country. At the anecdotal level, the existence of a number of cases in which governments have suddenly and unexpectedly reformed their FITs which have been particularly generous adds credence to this interpretation (e.g., Voosen, 2009; White et al., 2013).

Another explanation concerns productivity differences across countries. In particular, high solar FITs are typically used to compensate for the low capacity utilisation rates of solar PV panels, because a low FIT would not be sufficient for solar energy companies to break-even in countries whose natural conditions do not provide comparative advantage in the solar energy area. This suggests that low profitability and limited potential of solar energy in those countries might have also possibly held up the entry of foreign investors.

Secondly, incentives under FITs differ from those under RECs: in particular, the results indicate that RECs have a negative effect on cross-border M&As in solar power (at least until the market share covered by the REC becomes very large). This may be due to the "undifferentiated" nature of incentives provided under REC regimes relative to FITs. Under many REC systems, electricity generated from different renewable energy sources receives equal support. This is not the case under most FIT regimes which have different schedules for different sources, with those furthest from market receiving greater support. On this basis, our finding of a negative significant effect of RECs on cross-border M&A in solar power is not surprising, since solar-generated power is generally more costly than wind power. In addition, the evidence presented suggests that FITs encourage more diversified M&A than RECs, where diversification is defined as the number of sectors in which the merged company operates after the M&A. This too would be a consequence of the differentiated nature of support under FITs relative to RECs.

With respect to policy implications, this study highlights the trade-off between policy generosity, policy credibility and dynamic efficiency. Since less mature technologies are usually more expensive, targeting them through discretionary FITs which favour less mature technologies incentivises their deployment. However, this may be costly in terms of fiscial implications and in terms of risk exposure. Since there is large uncertainty about the learning rates of emerging technologies, FITs might provide overly-generous support to specific technologies that might not prove to be viable, or which may be superceded in the future. On the other hand, RECs which do not provide differentiated incentives will favour more mature technologies, such as wind energy, without spurring innovations in emerging technologies – including those that may be needed in the future.

The paper proceeds as follows. A discussion of renewable energy policies and the incentives that they give to investors will be given in section 2. After this, Section 3 describes the data; Section 4 explains the methodology; and Section 5 discusses the results of the study. Section 6 presents policy implications and conclusions.

2. RENEWABLE ENERGY POLICIES AND EXPECTED EFFECTS ON M&A

Role of policy in the development of renewable electricity technologies

The share of renewable energy is less than that which is socially optimal in the absence of policies which internalise the climate-related externalities.[7] In order to favor renewable energy, governments in many countries have been applying the so-called 'carrot and stick approach'. In this approach, 'stick policies' such as pollution taxes penalise polluters, while 'carrot policies' such as feed-in-tariffs (FIT) and renewable energy certificates (REC) favor renewable energy companies, reducing their initial disadvantage vis-à-vis the fossil-fuel sector. As stressed by Gillingham and Sweeney (2012), the primary barrier to the implementation of low-carbon technologies is that "such technologies have not advanced far enough to be cost-competitive with the fossil-fuel technologies".

Both stick and carrot policies are positively associated with the development of new technologies, increasing incentives for innovation and deployment. However, since the policies penalizing pollution have typically been relatively lax (see, e.g., Nordhaus, 2011),[8] additional policies have been applied to promote renewable energy generation. Although a variety of instruments have been used, FITs and RECs seem to have been the major instruments incentivizing the deployment of renewable energy technologies in the last several years.[9] For example, since the end of 2006 FITs have become the main policy instrument in Europe (Haas et al., 2011).

In addition both policies have also contributed to technological innovation (Johnstone et al., 2010). However, with respect to the incentives for innovation, the literature suggests that R&D policies may be more efficient in spurring innovations in renewables in comparison to other policies. For example, Dechezleprêtre and Glachant (2013) find that public R&D directed at innovation in wind technology is more efficient in inducing innovation than FITs and standards. Based on patent data of 25 countries over the period 1978-2003, Johnstone et al. (2010) find that technology-specific R&D subsidies (measured by sector-specific R&D expenditure) have a significant and sizeable effect on innovation in wind, solar, and geothermal. As pointed out by Jaffe (2012), efficient climate policy must include both carbon-price policy and technology policy that would provide support the commercial improvement and diffusion of new technologies.

Policy Choice: FITs and RECs

In the period studied (2005-2011), most governments promoted renewable technologies by FIT and REC policies. FIT schemes offer long-term contracts to renewable electricity producers, compensating for the higher costs of particular renewable energy sources. A REC policy obliges electricity suppliers to supply a certain percent of their electricity from eligible renewable energy sources. RECs are issued to certify that the supplier has purchased renewable energy. Therefore, the main difference between FITs and RECs is that i) FITs are a price-based instrument, while RECs are a quantity-based instrument; and ii) FITs have typically been set differentially at the level of the specific energy source, while RECs cover a portfolio of technologies.

In particular, FITs benefit energy producers in a particular renewable energy technology by fixing their price at a higher value than the market price of electricity (where market price may be either average price, or actual market price at the time at which the electricity is supplied). Since FITs are typically set per energy source, they allow for the compensation of differences in the producer costs of specific sources relative to each other and relative to fossil-fuel technologies.

In contrast, RECs are issued for a fixed quota of renewable energy, typically covering a set of renewable technologies in an undifferentiated manner. In most cases they can be traded among the market participants thus leading to a more efficient allocation of production. In Europe, these are also known as ‘tradable green certificates’. Portfolio standards (which can be considered as non-tradable RECs) would have a similar effect to RECs, although allocation of resources would be less efficient. Comparing both types of policies to each other, Menanteau et al. (2003) conclude that a FIT system is more efficient than a competitive bidding system such as tradable green certificates. Yet, the latter system may still be interesting in international contexts where trading possibilities are greater, and there is less chance that one operator could supply virtually all the market. Focussing on the policies that were adopted in the UK and Germany to encourage the development of wind energy, Butler and Neuhoff (2008) find that FITs reduce costs to consumers and result in larger deployment than other policies.

Haas et al. (2011) provide a historical overview of the main promotion strategies for electricity from renewable energy sources in Europe. Based on the existing evidence, on average in Europe, technology specific financial support measures performed more effectively than quotas in attracting private investment (Haas et al., 2011). However, this may also be due to design. In particular, Dinica (2006) argues that it is not the type of support instrument *per se* that influence investor behaviour, but its risk/profitability characteristics. Therefore, an empirical analysis also needs to account for aspects related to the design of these instruments. In this respect, it would be very relevant to account for differences in the type and the *generosity level* of both instruments and the fact that FITs have typically been set *per technology*, while RECs have not.

Policy differentiation across energy technologies and the renewable energy portfolio

Although FITs and RECs both promote renewable energy technologies, their effects on M&A activity may differ across renewable energy technologies. This is because RECs typically apply to a wide range of renewable sources in an undifferentiated manner. Conversely, FIT values are usually differentiated according to energy technology or energy source, with those with lower production costs being relatively less generously supported. Couture and Gagnon (2010) discuss different ways to structure FIT policies, explaining that in those jurisdictions which succeeded to attract private investment in renewable energy generation, the FIT levels offered to particular projects are determined as closely as possible in relation to the specific generation costs, taking into account technological maturity and ecological conditions.

Thus, under RECs those energy technologies with the lowest production costs, such as wind energy technologies, may be particularly favored, as they will be the ones for which it is most profitable to meet the quantity obligation. Stated differently, more mature technologies stand to benefit from RECs. Conversely, by adopting a FIT-portfolio policy, a government might aim at increasing the deployment of less developed technologies encouraging early deployment of less mature technologies. However, this is only justified in the case of high learning rates that would compensate for the costs incurred.

There is evidence of such effects in the area of innovation. For example, Johnstone et al. (2010) find that RECs are more likely to induce innovation in technologies that are close to being competitive with fossil fuels, while technology-specific FITs provide innovation incentives for more expensive, emerging technologies. Thus, high FITs could in principle result in the earlier deployment of more expensive technologies relative to RECs. Yet, the uncertainty about the optimal technological portfolio and the high costs associated with emerging renewable energy technologies suggest that differentiated public R&D support to those technologies may be warranted (see Albers et al. 2013). However, whether policies targeted at the level of the output (electricity generation) rather than upstream (i.e. R&D) remains an open question.

The differentiation of support levels under FITs and not RECs is likely to have another effect on investor incentives. If differentiation in FITs is designed in such a manner to compensate for differences in production costs of renewable energy relative to fossil fuel energy sources, the investor will be indifferent between targets with different energy profiles. Assuming that the investor is not targeting specific technologies for other reasons (i.e. acquiring complementary expertise), the FIT regime should result in a more diversified basket of renewable energy sources in the economy.

This can have a value in and of itself, minimising risks in the face of uncertainty. However, in the area of renewable energy there is another benefit associated with possessing a diverse portfolio of renewable energy sources. As the share of renewable energy increases, a wider portfolio of renewable energy sources will be required to reduce the correlation between different sources, and thus reduce problems associated with intermittency (Benatia et al., 2013).

Price uncertainty and policy risk under FITs and RECs

Thus far the discussion has focused on the levels of 'generosity' associated with different policy measures (favoring different energy sources to a different degree) and the effect that this has on incentives for investment in different sources and on the diversification of the basket of renewable energy sources which are targeted. However, the degree of "certainty" associated with a given level of support provided can also be important. Two measures of equivalent apparent generosity, but with different levels of uncertainty may have very different effects on investor behavior. This has two countervailing elements.

On the one hand, it has been argued that, relative to RECs, FITs provide a degree of price certainty over the investment planning horizon. This can have a particular value in new fields of investment such as renewable energy where financial markets may have difficulty assessing the risks associated with different projects. There is some evidence supporting the view that the greater level of price certainty associated with FITs can encourage greater investment than would be the case under RECs of similar generosity (see Cárdenas-Rodríguez et al., 2013).

However, on the other hand, it is important to bear in mind that private investors must also consider risks. One of the risks that may hinder investment concerns unexpected policy changes. Such risks may be particularly difficult for investors to assess, with the commitment of policymakers difficult to assess. Under rational expectations of economic agents, the lack of commitment may result in hold-up of investment.[10] This is as of true of environmental policy (e.g. Requate, 2005; Brunner et al., 2011) as it is in other policy domains.[11] With respect to renewable energy, White et al. (2013) discusses two recent examples of drastic renewable policy changes – a revision of FITs in Ontario, Canada, and an unexpected major change in the bioenergy policy in Norway – arguing that the loss of credibility will make it difficult to raise private capital for future investments.

Thus, when making a comparison between FITs and RECs, we need to also consider the perceived policy risks associated with the two instruments. Investors may see FITs as being less "credible" over the longer term if economic circumstances change. For example, some countries reformed their FIT regimes in the face of the economic crisis of the late 2000s. Conversely, countries rarely reduced RECs even though their economic implications (electricity prices, fiscal impacts) may have been equally important.

In addition, since RECs typically cover several energy sources (e.g., solar, wind, marine and geothermal technologies) in an undifferentiated manner, they may be less vulnerable to political uncertainty with respect to changing policy attention to a particular technology. Note that both countervailing components are relatively large in the case of generous technology-specific FIT policy, directed to a particular energy source; which suggests that such a policy might be regarded as more risky by private investors.

Differences between domestic and cross-border acquisitions

There is no question that policy design affects the levels and composition of investment within the renewable energy sector. Therefore, the precise mix of targeted technology-specific R&D and other policies and the implementation of FITs and/or RECs, will affect the degree and nature of specialisation in different renewable sources. For instance in Europe, Denmark ‘specialises’ in wind energy, Sweden and Germany in bioenergy, Germany and Spain in solar, and Norway and Austria in hydropower (as pointed out by Nesta et al., 2012).[12]

However, the effects of policy regimes on domestic and cross-border investment may differ. Cross-border acquisitions represent a particular form of entry in foreign markets, which differ from domestic acquisitions in both costs and benefits for investors. On the benefit side, an acquisition can be an attractive strategy by providing access to local expertise and local assets in the target country. In particular, the literature emphasizes that cross-border acquisitions are associated with additional benefits in terms of access to other markets, offering certain locational advantages, e.g. markets with more demand, lower production costs due to locational advantages, weaker competition in the market. According to the resource based perspective on acquisitions (Madhok, 1997), technological capabilities of targets may be important.

The empirical literature has found significant technological motivations in cross-border acquisitions in many markets; firms undertake M&A in order to facilitate follow-on innovations (Shimuzu et al., 2004; Bertrand, 2009; Stiebale, 2011; Frey and Hussinger, 2011). This effect may arise due to the international scope of technology markets and a limited number of suitable domestic targets in a particular knowledge field. As discussed by Frey and Hussinger (2011), this is a consequence of either due to i) anticipation that the merger will be blocked in case it exceeds the antitrust policy threshold; ii) fierce product market rivalries within national markets; iii) lower probability of finding a suitable domestic technological target because domestic technology markets are already largely consolidated.

However, when investing in those tangible and intangible assets, the acquirer faces information asymmetry and uncertainty. To this end, cross-border acquisitions are also both more risky and more costly than domestic acquisitions. Additional costs are associated with higher costs of searching for the target and a more complex, longer integration process than in the case of domestic acquisitions. The literature on investment emphasizes the importance of a stable institutional environment for foreign direct investment (FDI), of which acquisitions account for about 80%, when considering investments from industrialized countries (Conn et al., 2005). For example, Köhler (2010) indicates that banks are systematically more likely to be taken over by foreign credit institutions if the regulatory process is transparent. Also, better corporate governance in the target country can increase gains of acquisitions (Danbolt and Maciver, 2012).

Therefore, higher information asymmetry and uncertainty for cross-border investors, and less knowledge of the host’s country policy environment, implies higher policy risks perceived by these investors. This is likely to be especially true in the renewable energy sector, where the risk of policy change is compounded with the technology risk. Besides, both foreign and domestic investments are (at least partly) financed by loans, and foreign banks providing loans for cross-border acquisitions also face more information asymmetry regarding target’s country policy in comparison to domestic banks. Severe information asymmetry between the borrower and lenders affects the relationship between the lender and the borrower (Sufi, 2007). Thus, banks may apply higher interest rates on such loans, which may in turn increase the aversion of foreign investors to the policy risks of the target country, in comparison to domestic investors.

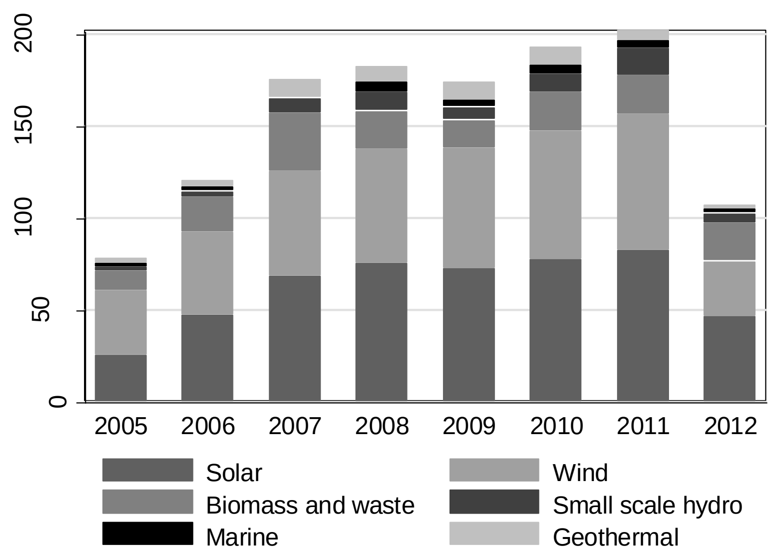
Therefore, from both cost and benefit perspectives, there are reasons to expect that the response of cross-border acquirers to policy changes may differ from that of domestic acquirers. First of all, since foreign acquirers’ entry in the host market is more complex, and the integration process usually requires more time, they may have a longer investment horizon. Also, they are more likely to have a technological motivation. If the reason for entry is technological, acquirers might also choose a longer-term perspective. Secondly, cross-border acquirers face more information asymmetry and uncertainty, which means that they may be more likely to overestimate the probability of a negative event. Differences in policy type (REC and FIT), as well as in policy specificity and generosity affect the incentives for private investment. We exploit the differences in the behavior of domestic and cross-border acquirers to provide evidence concerning certain aspects of REC and FIT policies, highlighting important policy design issues that need to be addressed in order to achieve a good investment climate in the renewable energy sector and encourage private investment efficiently.

3. DESCRIPTIVE ANALYSIS OF M&A IN THE RENEWABLE ELECTRICITY SECTOR

The data considered in this study originate from the Bloomberg New Energy Finance database BNEF (2013a). The M&A data provided by BNEF comprise information on all publicly known M&A deals in new energy finance. Hence, the trends observed in the database characterise general trends in the acquisition activity of this sector. The sample used in this paper includes 1 231 records of acquisition deals that have been completed in the area of renewable electricity generation over the period 2005-2012.[13] It covers three main acquisition types: equity (90%), strategic stake in a public company (3%) or an asset (6%). The sample includes 1 110 companies as targets and 784 companies as acquirers, as some companies participated in more than one deal. By their ownership status, most targets are subsidiaries, while most acquirers are public quoted companies. Each record can be uniquely identified by the combination of the target, acquirer and the year of the deal completion.[14]

Figure **1** shows the evolution of the number of M&A by sector over time. The definitions of the sectors are provided in the Appendix. As highlighted before, the expansion of the new energy sector in the economy has been accompanied by an increase in M&A activity. Over the period 2005-2007, a steep increase in the number of transactions in most areas can be observed, with some small decline in 2009, possibly due to the financial crisis of 2008, and a subsequent recovery in 2010 and 2011, when over 200 deals took place. There was another sharp fall in 2012, coinciding with the 11% downturn in global investment in renewable energy in the same year, probably due to regulatory uncertainty and policy changes in big markets, including the US, India, Spain and Italy, according to BNEF (2013b). Note that the fall shown by the M&A data has been much deeper, which could be either because of reduced policy support or higher sensitivity of this type of activities to regulatory risks.

Figure 1. Number of acquisitions, 2005-2012



Source: Own calculation based on BNEF (2013).

Almost 40% of M&A deals occurred across border. Altogether, the dataset covers acquirers from 47 countries and targets from 55 countries. Table 1 illustrates the extent of cross-border transactions involving targets and acquirers from the six countries with the largest number of M&A deals. Most transactions in the dataset involve firms from the United States. Furthermore, there are relatively many deals (above 55 on each side) involving firms from Canada, China, Germany, United Kingdom, and Spain. About 60% of all targets and acquirers correspond to these countries.

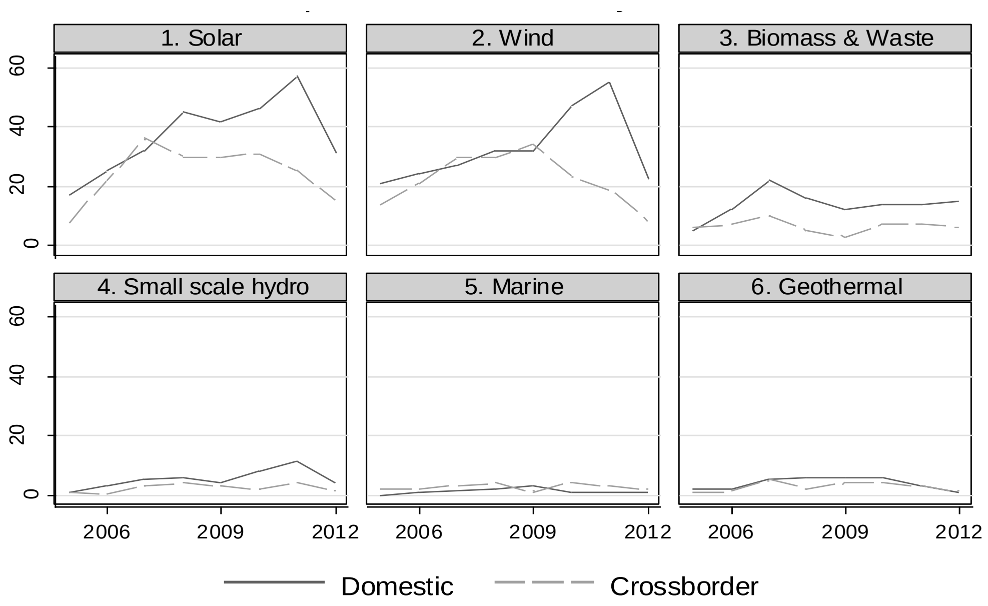
Table 1. Share of cross-border acquisitions of selected countries, 2005-2012

	Targets		Acquirers	
	Number of M&A	% cross-border	Number of M&A	% cross-border
Canada	62	40%	62	40%
China	123	23%	119	20%
Germany	136	45%	143	48%
Spain	56	38%	58	40%
United Kingdom	85	54%	59	34%
United States	283	31%	266	27%
World-wide (including the rest)	**1,231**	**39%**	**1,231**	**39%**

Note: The table details transactions of the six countries, where the number of both targets or acquires was greater than 55.

Figure **2** shows the evolution of domestic and cross-border acquisitions across renewable electricity sectors, highlighting a relatively large number of acquisitions in solar, wind, and 'biomass and waste', and a notable difference between the patterns of domestic and cross-border acquisitions in these sectors. The Figure shows that the peak of M&A in 2011 is mainly attributable to the 'boom' in domestic acquisitions in wind and solar (and to a lesser extent small scale hydro) in that period. On average, domestic M&A activity levels exceeded cross-border levels.

Figure 2. Evolution of domestic and cross-border acquisitions by renewable energy source, 2005-2012

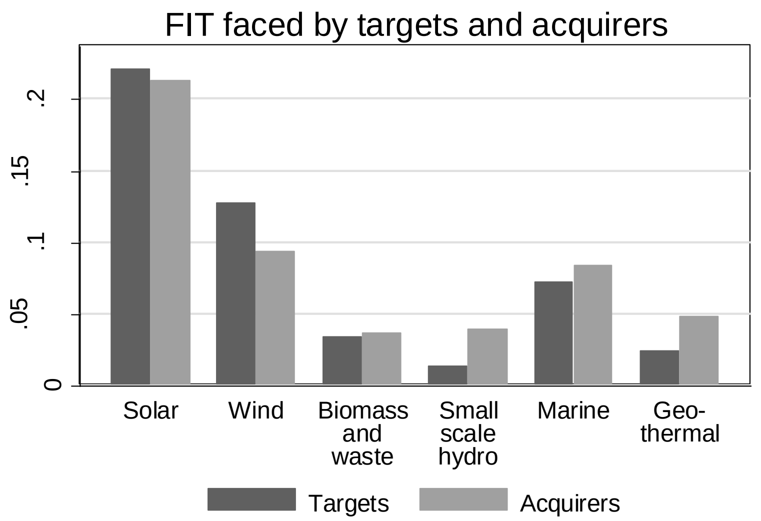


Source: Own calculation based on BNEF (2013).

The data on acquisitions have been linked to the new Renewable Energy Policy Database (OECD-EPAU 2013) providing harmonised country-level data on FIT levels and REC quotas over the period 1978-2011. Technology specific FITs exist for wind, solar PV, small-scale hydro, marine, geothermal, biomass and waste technologies. To match this information with the technology classification, separate tariffs on waste and biomass are aggregated into an average tariff for waste & biomass (using simple averages). Since the Renewable Energy Policy Database provides FIT values in national currencies, these values have been converted into US dollars (in current prices) by multiplying FIT by the exchange rate.

Figure **3** shows the average FIT values at the aggregated country-industry level,[15] separately for acquirers and targets, focusing on differences across sectors. For solar, and to a greater extent for wind energy, the FIT in the target's country is, on average, higher than the FIT in the acquirer's country. It might suggest that a relatively higher FIT for these two industries might have also attracted foreign acquirers to these countries.

Figure 3. Average FITs in the domestic countries of targets and acquirers at the time of acquisition, 2005-2011



Source: Own calculation using BNEF (2013) and Renewable Energy Policy Database (OECD-EPAU 2013).

4. METHODOLOGY

This section explores the relationship of the target country's policy framework with the likelihood of cross-border deals, and with deal diversification. Sections 2 and 3 have highlighted the differences that exist between i) domestic and foreign M&A on the one hand, and ii) RECs and FITs on the other hand. Econometric analysis will seek to relate the observed patterns of acquisitions – in particular, the relative likelihood of cross-border deals over domestic deals and the variation in diversification levels in different countries – to renewable energy policies adopted by these countries. Since the policy data are available only until 2011, the period is limited to 2005-2011. Furthermore, the analysis is restricted to the solar and wind sectors, because most of observations come from these two industries.[16]

Hypothesis 1: *Since foreign acquirers face more information asymmetry and uncertainty, the response to policy characteristics (instrument choice, generosity) may differ between the two groups.*

Hypothesis 2: *Since FITs are set per technology and RECs for a basket of technologies, FITs are likely to be associated with a greater diversification of deals in terms of energy sources than RECs.*

Both models are specified below, using letters *F* and *G* for the respective functions. Given the nature of dependent variables (a binary variable in the first equation, and a count variable in the second one), the first equation is estimated by Logistic regression and the second one by Poisson regression.[17] Cross-country variation in FITs and RECs is explored to evaluate their relationship with the likelihood of cross-border acquisitions in the M&A sample and on the diversification of M&A deals. Deal diversification is defined as the number of new energy industries (out of 6) covered by the resulting entity.

Prob {Cross-border M&A =1} = F (FIT and REC generosity in the target country; Relative difference between the target and the acquirer in GDP, R&D intensity, investor protection; Deal characteristics; sector and year fixed effects)

Deal diversification = G (FIT and REC generosity in the target country, sector and year fixed effects)

The first regression includes additional control variables (Summary statistics can be found in the Appendix; Table 2 summarises the mean values of the main variables used in regression for domestic and cross-border deals). The most important deal characteristics are the technological motivation and the industry diversification. The technological motivation will be proxied by the dummy 'Technological deal', taking value 1 for deals involving a target and an acquirer, which both filed at least one application under the international Patent Cooperation Treaty in the last 10 years before the deal.[18] The comparison of the mean value of this variable for domestic and crossborder deals suggests that foreign deals are more likely to be technologically motivated than domestic deals (see Table 2).

Furthermore, the regression includes a number of variables controlling for country pairwise differences. In particular, we control for differences in GDP, R&D intensity in each sector,[19] and the level of investor protection. With respect to the first two variables, the literature shows that both relative market size and relative strength of a country's science base drive FDI flows in research and development (Kuemmerle, 1999). Therefore, larger countries may be more attractive for cross-border entry into the renewable energy technology markets, and this is also what we see in our sample (Table 2). Furthermore, foreign countries with more research expenditures in a particular sector may have more innovative targets, which may also attract foreign buyers. However, the opposite is also true, higher R&D intensity of the acquirer country is probably associated with more technologically advanced acquirers, who look for the possibility of locational diversification, which would lead to an opposite effect of pairwise differences in R&D intensity on the probability of a cross-border M&A. Therefore, the overall effect of this variable is generally ambiguous. For the cross-border deals that are present in our sample, target country has on average slightly lower R&D intensity than the acquirer country (Table 2).

Finally, the literature also suggests that the difference in corporate governance systems may be important for cross-border M&A (see Danbolt and Maciver, 2012 – on the analysis of particular aspects of governance systems). Therefore, we also control for differences in investors' protection between countries, as acquirers' probably prefer countries offering better protection to investors. To measure it, we use the 'strength of investor protection' index constructed by the World Bank (2013), which is the average of the extent of disclosure index, the extent of director liability index and the ease of shareholder suits index. The index ranges from 0 to 10, with higher values indicating more investor protection (Djankov, La Porta et al., 2008).[20] Table 2 shows a greater value of investor protection in target country for cross-border deals.

For the sake of completeness, Table 2 includes also the policy variables that charactrise policy generosity in the target country. We observe a greater mean value of FIT policy and a lower mean value of REC policy for cross-border deals in comparison to domestic deals. Finally, we observe that crossborder deals are on average more diversified than domestic deals.

Table 2 Summary of the mean values of the variables for all, domestic, and cross-border deals

	All deals	Domestic deals	Cross-border deals	Number of domestic deals	Number of cross-border deals
Dummy Technological deal	0.091	0.087	0.096	449	311
GWh ratio (tar,/acq)	2.882	1	5.688	371	249
GDP ratio (tar./acq.)	2.314	1	4.394	429	271
Difference in R&D intensity	-0.0004	0	-0.001	370	246
Difference in investor protection	0.192	0	0.490	449	289
Wind energy	0.478	0.468	0.492	449	311
FIT generosity in the target country	0.105	0.094	0.121	449	311
REC generosity in the target country	0.227	0.232	0.219	449	311
Diversification	1.771	1.653	1.942	449	311

Source: Own calculation using BNEF (2013), Renewable Energy Policy Database (OECD-EPAU 2013), IEA (2013a), World Bank (2013), and the OECD Statistics database.

The acquirer's country policy may be seen as a control variable. However, the relationship to this control variable is ambiguous. On the one hand, a higher policy generosity level may weaken the incentive to enter another country market, because the acquirer already enjoys a generous policy support at home. On the other hand, a possible mechanism is technology diffusion (e.g., Lovely and Popp, 2011; Dechezleprêtre et al., 2012). According to this mechanism, acquirers with more advanced technologies may also be better capable of exploiting opportunities in less developed renewable markets, which offer other advantages (e.g., in terms of market size, less fierce competition, the presence of certain natural resources). Therefore the relationship is ambiguous. A robustness check has been conducted, showing that the inclusion of the acquirer's policy generosity does not change the results.[21]

Finally, an important policy issue concerns a possible rent leakage to foreigners. Generous renewable energy policies generate rents which accrue to renewable energy producers. Therefore, governments might undertake measures limiting foreign acquisitions of domestic targets to ensure that rents do not accrue to foreign firms. If so, only countries with strong protection against foreign M&As would have high FIT levels, which would cause endogeneity bias in our estimation. It is however unlikely that rent leakage was an important consideration in practice for two reasons. First, acquisition targets usually cover only a small market share (since targets are typically relatively small companies, and their number is small in comparison to the total number of companies benefiting from these policies). Second, the risk of rent leakage is mitigated by the fact that foreign acquirers need to compete with domestic acquirers that face lower transaction costs. Based on anecdotic evidence on the photovoltanic solar energy industry in Spain, foreigners did not seem to experience difficulties in this market during the high FIT period.[22] Furthermore, countries in which stronger restrictions to incoming FDIs are observed (as measured by the OECD 2013 FDI Regulatory Restrictiveness Index) are generally also those with relatively *less* generous FITs.

5. RESULTS

Relationship between policy generosity and the likelihood of cross-border deal

Table 3 presents the coefficients of a logit regression of the likelihood of cross-border M&As on FITs and RECs in the target's country. The FIT and REC policy generosity variables have been normalised on the yearly maximum values across all countries for which information is available; therefore, they reflect the policy generosity in comparison to other countries in the same year. Column (1) reports estimates of a specification which includes only linear terms in FIT and in REC. The estimates show a positive and significant coefficient on FIT, and a positive but not statistically significant coefficient on REC.

Column (2) controls for pairwise country differences in GDP, R&D intensity and investor protection. The estimated coefficients are positive and significant, suggesting that a greater GDP, a higher R&D intensity, and a higher level of investor protection in the target country relative to the acquirer country are positively associated with the likelihood of cross-border M&A. With respect to the policy variables, the coefficient on FIT is still positive and significant, lending support to the positive relationship found in Column (1), but the coefficient on REC is now negative. In fact, the REC variable corresponds to the REC quota (as a percentage of electricity production). Therefore, the coefficient estimate on REC reported in Column (1) is affected by omitted variable bias, since we do not control for the size of the market for renewable electricity. Another explanation for the unexpected result on REC may lie in imposing the linear functional form for the relationship between policies and M&A, while this relation may be non-linear (and even non-monotonous).

Columns (3)-(5) test these potential explanations. In particular, Column (3) includes quadratic terms to test the assumption of linearity in the relationship between M&A and policies. The results show that the quadratic term is significantly negative for FIT. This suggests that, at a low level of FIT, an increase in its generosity is associated with increases in cross-border M&A; however a "too generous" FIT may actually decrease it. As discussed above, a potential explanation for this inverted U-shaped relationship may lie in policy credibility: since FITs are often financed (at least partly) from public budgets, too high FITs might raise credibility concerns. These concerns may have a stronger effect on cross-border acquirers, who generally face more information asymmetry and uncertainty about foreign markets and likely future policy developments. However, also other factors could affect the relationship between the FIT variable and the likelihood of cross-border transaction, which we will discuss separately below in more detail.

Unlike the results on FIT, the results on REC are insignificant in Column (3). Since the quadratic term for RECs is insignificant, it is dropped in Columns (5) and (6). Those include the ratio of electricity production in the target's and the buyer's country (the electricity production of the main fossil-fuel generators in GWh)[23] as a proxy for the size of the relevant market; this variable is also interacted with the REC. Both the non-interacted and the interacted variables have a positive significant coefficient. The combination of the negative (insignificant) coefficient on the REC quota and the positive significant coefficient on the interaction term with the market size ratio in Column (5) suggests that RECs attract foreign acquirers only if the target country has a substantially larger renewable energy market than the home country: at least twice as large as the home country, based on Column (5). Since both variables that have been added in Column (5) are significant, this is the preferable specification for a separate analysis of the solar and wind sector.

The results of the separate analysis for solar and wind energy are presented in Columns (7) and (8). Since these regressions include fewer observations, some coefficients have now a lower significance level. The regressions show that FITs are associated with a higher likelihood of cross-border M&As in both sectors. However, the negative quadratic term for FITs is significant only for solar energy. The negative significant coefficient on REC in Column (7) lends support to the idea that RECs, which are expected to encourage only the cheapest technologies, are also unlikely to attract foreign companies to undertake acquisitions in more expensive renewables.

Table 3 reports estimated coefficients of a logit model, not marginal effects. Table 4, therefore, provides the estimates of the average effect of a 10% increase in policy generosity on the likelihood of a cross-border deal at the mean value of all the explanatory variables. The reported marginal effects show that a 10% increase in the generosity of FIT relative to the average level would be associated with an increase in the likelihood of a cross-border M&A of almost 12%, while a 10% increase in REC generosity would increase it only by about 2%. Note that this positive effect hinges upon the average relative market size (GWh ratio) being 2.883. For values of GWh ratio below 2, the correlation between REC and the likelihood of cross-border M&A would have been negative.

Additional analysis of the inverted U-shaped relationship on FIT

As explained, the inverted U relationship found for FIT may be driven by credibility concerns of foreign investors. However, two other aspects need to be considered. First, it is possible that the result is driven by the data for particular countries. Secondly, different ecological conditions across countries may affect the productivity of the installed capacity. For example, Spain has more hours of sunshine than Germany, therefore the levels of FITs need to be considered in relation to these conditions.

First, to ensure that the result has not been driven by particular countries, we exclude certain countries from the estimation sample, to test whether the result still holds after their exclusion, which has turned out to be the case. Table 5, Columns (1)-(3), show that the quadratic coefficient on FIT is still significant after the exclusion of Germany, Italy and Estonia. The focus on these three countries is explained by the fact that Germany and Italy both have relatively high FITs and relatively many M&A deals in the solar sector; and Estonia has a high wind FIT, which was much higher than in any other country from the M&A sample.

Secondly, to test for the effect of natural conditions, the FIT variable is rescaled with the sector-specific country-level productivity coefficient. The idea is that the same solar panel will be more productive in countries with more sunshine; as well as a wind turbine will be more productive in a country with a higher wind speed. For solar energy, the coefficient has been constructed utilising data on theoretical amounts of electricity production for a given solar capacity. And for wind energy, the average differences in wind speed have been used.[24]

Table 5, Column (4), presents the regression results using the adjusted FIT variable instead of the initial variable. The coefficient on the quadratic term is insignificant. Therefore, after adjusting for productivity differences, it seems that the likelihood of a cross-border acquisition is increasing with respect to FIT generosity. This result suggests that, on average, countries adopting higher solar FITs were actually the ones with less favourable ecological conditions for solar power, and thus with lower expected gains from that energy source; while countries with more favourable ecological conditions offered FITs that were more lucrative in terms of profits. With unfavourable ecological conditions, investment may be not appealing even under relatively ‘generous’ FITs.

Analysis of the relationship between policy and differentiation

As discussed above, by differentiating support levels between renewable energy sources FITs support different investment targets than undifferentiated RECs. For the same reason, FITs may also encourage more diversification across renewable electricity technologies. Therefore, the instruments may also affect the diversification of M&A deals.

Table 6 shows the results of regressions for the relationship between M&A and diversification, where diversification is measured by the number of all the renewable electricity sectors of the acquirer-target pair. As before, the sample includes only M&As in solar and wind energy. Since the dependent variable takes integer values, the estimation uses a Poisson model. The results are presented in the exponential form: coefficient values above one correspond to a positive effect, and below one to a negative effect. The results show that cross-border M&A deals and M&As in wind energy are on average more diversified.

Summarising the results

Summarising, the results show the following:

(1) FITs are linked to cross-border M&As in both wind and solar energy sectors; but while the relationship between FITs and cross-border M&As is linear in the wind sector, the relationship has an inverted U-shape in the solar energy sector: while a moderate FIT is positively related to cross-border M&A, a too generous FIT may actually decrease it.

(2) There may be two explanations for this funding. One possibility lies in policy credibility: as high FIT level could not be sustainable for a long time, credibility concerns could be deterring foreign investors (irrespectively of market conditions). Secondly, also the differences in natural conditions across countries affect the decision of foreign acquirers to a larger degree. The analysis suggests that countries adopting higher FITs were mostly the ones with less favourable ecological conditions for solar energy. This consideration possibly affected the choice of targets by cross-border investors.

(3) Incentives under FITs differ from those under RECs: in particular, RECs have a negative relationship with cross-border M&A in solar power. The finding lends support to the hypothesis that RECs, which encourage only the least costly generating technologies, are unlikely to encourage foreign acquirers to target more costly renewables.

(4) Finally, the evidence found suggests that FITs encourage more diversified M&As than RECs, where diversification is defined as the number of sectors in which the merged company operates after the M&A. Also, M&As in wind energy are more diversified that M&As in solar energy; and cross-border M&As are on average more diversified, than domestic M&As.

Table 3. Relationship between cross-border M&A and policy, 2005-2011

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Solar and Wind			Solar	Wind
FIT	1.206**	2.021***	6.600***	6.282***	6.960***	6.493*	10.773**
	(0.533)	(0.747)	(2.278)	(2.286)	(2.287)	(3.512)	(4.575)
FIT^2			-8.380**	-7.754*	-8.471**	-10.082*	-12.581
			(4.027)	(4.038)	(3.965)	(5.727)	(13.357)
REC	0.174	-0.873*	-2.761*	-0.691	-1.691***	-4.100***	-0.231
	(0.307)	(0.466)	(1.475)	(0.483)	(0.628)	(1.140)	(0.744)
REC^2			3.507				
			(2.298)				
REC x GWh ratio (tar./acq.)					0.873***	1.491***	0.238
					(0.205)	(0.299)	(0.255)
GWh ratio (tar./acq.)				0.356***	0.172**	0.155	0.240**
				(0.080)	(0.078)	(0.122)	(0.119)
GDP ratio (tar./acq.)		0.542***	0.556***	0.166**	0.137*	0.086	0.167
		(0.070)	(0.072)	(0.080)	(0.082)	(0.117)	(0.116)
Difference in R&D intensity		21.363**	22.097**	27.870***	25.111**	0.203	39.350**
		(9.550)	(8.893)	(10.012)	(9.801)	(18.098)	(15.984)
Difference in inv. protection		0.233**	0.257**	0.221*	0.180	-0.103	0.392**
		(0.113)	(0.110)	(0.120)	(0.120)	(0.198)	(0.165)
Dummy Wind energy	0.079	0.419*	0.417*	0.451*	0.591**		
	(0.180)	(0.254)	(0.252)	(0.261)	(0.275)		
Dummy Technological deal	0.175	-0.042	-0.097	-0.070	-0.080		
	(0.275)	(0.329)	(0.337)	(0.330)	(0.337)		
Diversification	0.226***	0.187**	0.167*	0.183**	0.172*		
	(0.071)	(0.084)	(0.085)	(0.088)	(0.089)		
Constant	-1.348***	-2.555***	-2.532***	-2.563***	-2.471***	-1.154*	-2.188***
	(0.343)	(0.483)	(0.484)	(0.491)	(0.503)	(0.670)	(0.582)
Observations	760	616	616	616	616	319	297

The table presents the coefficients of logistic regressions estimated at the deal level. The dependent variable takes value 1 for cross-border M&As and value 0 for domestic M&As. The policy levels are normalised by dividing by the yearly cross-country maximum values. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 4. Marginal effect of a 10% increase in policy generosity on the likelihood of cross-border deal, evaluated at the mean values of explanatory variables

	(5)	(6)	(7)
	Solar and Wind	Solar	Wind
FIT	0.122***	0.067*	0.239***
	(0.034)	(0.036)	(0.088)
REC	0.021*	0.010	0.011
	(0.012)	(0.020)	(0.014)

The table corresponds to specifications presented in the last three columns of Table 2. The values are calculated by taking 10% of the respective marginal effect values at means. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5. Test for alternative explanations

	(1)	(2)	(3)	(4)
	Solar and Wind			
VARIABLES	Excluding Germany	Excluding also Italy	Excluding also Estonia	Adjusting FIT for local production conditions
FIT	9.072***	7.804***	11.132***	
	(2.567)	(2.564)	(3.051)	
FIT^2	-9.456*	-10.369**	-11.187*	
	(4.953)	(4.365)	(6.303)	
FIT adjusted				3.258*
				(1.726)
FIT adjusted ^2				-1.912
				(2.076)
REC	-2.293***	-1.777**	-2.167***	-1.819***
	(0.696)	(0.694)	(0.749)	(0.638)
REC x GWh ratio (tar./acq.)	1.235***	0.976***	1.380***	0.841***
	(0.312)	(0.233)	(0.369)	(0.203)
GWh ratio (tar./acq.)	0.168	0.225***	0.259*	0.182**
	(0.113)	(0.085)	(0.155)	(0.079)
GDP ratio (tar./acq.)	-0.117	0.075	-0.235	0.135
	(0.142)	(0.090)	(0.211)	(0.082)
Difference in R&D intensity	25.062**	21.064**	24.005**	25.324**
	(10.876)	(9.723)	(11.456)	(10.245)
Difference in inv. protection	0.457***	0.141	0.456***	0.192
	(0.127)	(0.127)	(0.134)	(0.119)
Dummy Wind energy	0.602**	0.576**	0.581**	0.693**
	(0.281)	(0.283)	(0.296)	(0.296)
Dummy Technological deal	0.294	-0.103	0.234	-0.047
	(0.396)	(0.349)	(0.416)	(0.340)
Diversification	0.154	0.165*	0.130	0.192**
	(0.097)	(0.094)	(0.102)	(0.089)
Constant	-2.050***	-2.399***	-2.083***	-2.524***
	(0.543)	(0.516)	(0.567)	(0.511)
Observations	524	568	476	613

The table presents the coefficients of logistic regressions estimated at the deal level. The dependent variable takes value 1 for cross-border M&As and value 0 for domestic M&As. The policy levels are normalised by dividing by the yearly cross-country maximum values. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Regression results on the relationship between diversification and policy, 2005-2011

VARIABLES	Diversification of the M&A deal
FIT	1.316**
	(0.174)
REC	1.000
	(0.086)
Dummy Wind sector	1.607***
	(0.073)
Dummy Cross-border	1.152***
	(0.050)
Constant	1.270***
	(0.101)
Observations	760

The table presents the results of Poisson regression estimated on the sample of the solar and wind sectors. The diversification is defined as the number of new energy sectors covered by the merged entity. The coefficients are in the exponential form. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

6. CONCLUSIONS AND POLICY IMPLICATIONS

The analysis of the relationship between the renewable energy policies adopted by many countries – such as feed-in tariffs (FITs) and renewable energy certificates (RECs) – and foreign M&A deals indicates that both policies affected the inflow of foreign investors (through cross-border M&As). However, there is a stronger association with FITs than with RECs. This may be both because of the technology-specificity of FITs – encouraging investment also in less mature technologies – and because of the higher generosity of FITs, especially for solar energy in some countries.

While the relationship between FITs and cross-border M&A is positive for moderate levels of FITs, it is negative at high levels of FIT. The presence of this effect for solar energy deals might be due to different factors. A first hypothesis is that an excessively generous FIT may be less credible to foreign investors than to domestic investors, because foreign investors may exhibit higher levels of aversion to policy risk in the target country. A second hypothesis relates to the fact that countries with the most generous solar FITs are typically also those that lack a comparative advantage in the area of solar energy. This suggests that a high FIT level was trying to compensate for the low profitability and limited potential of solar energy in those countries, which still held up the entry of foreign investors despite the generosity of the policy. The analysis shows that FITs resulted in a greater diversification of M&A deals than RECs; possibly leading to investment in a broader range of electricity technologies in the long run.

It is worth stressing trade-offs that policymakers need to bear in mind. Since less mature technologies are usually more expensive, targeting them by FITs incentivises their deployment, but this may be costly, both in terms of a country's budget and in terms of risk exposure. Since there is large uncertainty about the learning rates of emerging technologies, FITs might provide excessive support to specific technologies that might not prove to be viable or which may be superseded in the future. On the other hand, RECs favour more mature technologies, such as wind energy, without spurring innovations in emerging technologies – including those that may be needed in the future. Therefore, this study highlights the trade-off between policy generosity, policy credibility and dynamic efficiency.

A potentially important consideration with respect to foreign investment concerns the possibility of rent leakage to foreigners. If the government was concerned about the rent leakage, this would affect the REC and FIT policy levels, causing bias in the relationship between policy and foreign acquisitions. However, it seems unlikely that this consideration had a decisive effect on policy levels in practice, because only a small market share is typically covered by M&A activity and foreign acquirers are already naturally disadvantaged by higher transaction costs of foreign acquisitions in comparison to domestic acquisitions.

Other issues, which fall beyond the scope of this study but deserve a consideration in future studies, concern the effects of M&A on innovation and competition and the need for consistency between FIT and REC policies, environmental policies explicitly penalizing pollution, and innovation policies encouraging research in the new energy field. In particular, by targeting particular technologies, public R&D policies also affect the direction of future innovations in the new energy area, thus they may complement, reinforce or weaken the impact of energy policies. Therefore, policy makers in these areas should coordinate their actions to exploit policy complementarities. Rather than encouraging a diversified portfolio through a single instrument targeted at the price of electricity (FITs), a combination of instruments may be more efficient. The optimal combination may be the use of undifferentiated RECs in combination with other policy measures for less mature technologies (i.e. R&D support), rather than reliance on the use of differentiated FITs.

NOTES

1 The views expressed in this paper are those of the authors and do not represent the official views of the OECD or of its member countries. Comments on the paper are welcomed, and may be sent to the corresponding author (Chiara.Criscuolo@oecd.org).

2 The "double market failure" refers to environmental market failure and research market failure, which is present also in other research markets (Jaffe et al., 2005).

3 The most common exit mechanisms for start-up investment are initial public offerings (IPOs) and M&As.

4 Market risk is compounded by regulatory risk, since the role of public policy is so central to the commercial viability of new energy projects.

5 Note that, in this paper, both terms *'acquisition'* and *'M&A'* are used interchangeably when referring to these deals.

6 The econometric analysis evaluating the effect of policies had to be limited to these two sectors, because of the too low number of observations on other sectors. Since the harmonised data on policies are only available until 2011, also the year 2012 is excluded from regressions.

7 Although wind power is now competitive with fossil fuel electricity generation in some areas, in most markets and for most sources of renewable energy this remains the case.

8 Nordhaus (2011), Weyant (2011) and Noll (2011) discuss the circumstances under which targeted policies may be needed to stimulate technical change in renewable energy technologies.

9 Haas et al., (2011) provides an overview on promotion policies in EU. At least in the period studied, FIT was the main instrument in Europe. Next to this, countries usually also applied some type of investment focused strategies, such as investment subsidies, soft loans, or tax credits. However, the data on levels of those instruments are not available.

10 Furthermore, the literature shows the importance of overall policy consistency for innovation. Nesta et al. (2012) find that renewable energy policies are significantly more effective in spurring renewable energy innovation in countries with deregulated energy markets: more precisely, it is "twice as effective" with respect to the average level of deregulation in developed countries. Klaassen et al. (2005) show that inconsistency between wind energy policies intended to stimulate innovators and policies directed at the adoption of these innovations may actually deter innovations in wind. Also protectionist policies, such as local content requirements – which make downstream renewable energy companies eligible for FITs only if they buy a certain share of their equipment from local producers – could potentially hurt investment incentives (OECD, 2013).

11 This is, of course, a variant on arguments presented in the context of macro-economic policy (e.g., Kydland and Prescott).

12 Johnstone and Haščič (2012) stress that intermittent renewable energy sources (wind, solar, ocean) present significant challenges to electricity grid management, arguing that focusing policy incentives on innovation in energy storage and grid management may obviate some problems associated with targeting R&D at specific generation technologies.

13 The original dataset starts in 1990, thus including more deals. However, since the new energy sector is still a new sector of the economy, the earlier period is characterised by relatively few M&A; e.g. less than 1% of M&A energy deals took place before 2000. Furthermore, our sample is smaller since we focus on sectors of renewable electricity generation.

14 We do not include duplicate combinations, when there were several records of the same two firms within the same date or year. In the case of transactions occurring in the same year, we left only the most recent transaction, as more complete. For transactions occurring within a few years, we keep only the first transaction. The first transaction seems the more relevant one, because it corresponds to the first purchase decision, which gives the owner access to the knowledge base of the acquired company. In principle, it is also possible that an acquirer subsequently buys several assets of the same company; however, this situation was not typical in our dataset.

15 The aggregation of the dataset results in 171 country-industry observations for which there was at least one deal in the period 2005-2011.

16 The third largest sector is ‘Biomass and waste’; however, this sector is relatively small in comparison to wind and solar. Besides, the analysis may be distorted by the fact that the data on sector include two different energy sources facing different FIT levels.

17 For the first equation, a robustness check has been conducted, using Probit model, to ensure that the results are not sensitive to the choice of the binary model specification. However, the alternative regressions always resulted in nearly the same value of log(pseudolikelihood) and the same direction and significance levels of the results. For the second equation, since the dependent variable is not over-dispersed (see summary statistics in Appendix), the Negative Binomial model is unlikely to offer an advantage over Poisson model (see also Santos Silva and Tenreyro, 2006) . Still, a robustness check has been conducted using Negative Binominal regression. The alternative model resulted in the same log(pseudolikelihood), confirming the outcome of the main estimation shown in Table 5.

18 To construct this variable, all firms’ names have been connected to the PATSTAT database in order to find out which firms had such applications. The matching procedure is described in OECD (2014).

19 R&D intensity is defined as the ratio of total RD&D expenditure over GDP divided by 1000. Taking the difference in R&D intensities is preferable to taking their ratio, in order to avoid missing observations because of zero R&D for wind or solar energy in some countries. The GDP variable is extracted from the OECD Statistics database. The data on the total R&D expenditure by sector are from IEA (2013a). Both variables are expressed in millions USD (constant prices, constant PPPs, OECD base year for GDP and 2012 for R&D expenditure).

20 Missing values (if any) were interpolated by using a linear function.

21 The results are not included for brevity; but are available from the authors upon request. The acquirer’s policy generosity variables are insignificant.

22 Based on Voosen (2009): “Chinese solar firms were sending container after container, flush with solar panels, to the country.”

23 The electricity production (in GWh) variable is extracted from IEA (2013b). It reflects the gross electricity production from the main activity producer electricity plants.

24 The average productivity coefficients on solar PV (per country) have been derived from IEA-PVPS (2013, Synthesis table). The coefficient is expressed as the amount of theoretical production with the solar capacity available by the amount of that capacity. The value is then normalised by dividing on the mean of all countries. The data on the average speed of wind comes from Benatia et al. (2013).

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APPENDIX: RENEWABLE ELECTRICITY SECTORS

Table A.1 Definitions of sectors in the Bloomberg New Energy Finance database (BNEF, 2013a)

Sector name	Sector description
Solar	The Solar sector covers all technologies which capture energy directly from the sun. These include direct production of electricity using semiconductor-based photovoltaic (PV) materials, use of concentrated sunlight to heat fluid to drive power generation equipment (solar thermal electricity generation or STEG), and passive methods which use solar to replace fossil fuel energy, for example to heat water. The photovoltaic sector is the largest of these in terms of investment volume, while passive is the largest in terms of fuel saved and carbon dioxide emissions reduced globally. However, PV is expected to dramatically reduce costs through new technologies and increased manufacturing scale, and is expected to break into new areas of energy demand over the coming decades.
Wind	Wind is the renewable technology that has had the biggest impact on our energy usage patterns over the past decade. The next decade will see continued activity, particularly in developing countries and offshore. The Wind sector includes components and subassemblies for wind turbines as well as manufacturers of turbines themselves. A big part of this sector, however, consists of the various developers, generators, utilities and engineering firms that have sprung up to exploit opportunities to build wind farms around the world.
Biomass & Waste	Generation of electricity and heat from biomass and municipal/industrial waste through incineration, gasification or anaerobic digestion. Most common feedstocks are residues from the forestry industry but specially-grown crops, such as willow or elephant grass are becoming increasingly important. In sparsely wooded areas mainly agricultural residues like straw or husks are used. Our database includes feedstock producers and traders, logistic companies, power generation equipment providers and energy producers.
Small hydro	The generation of electric power from the movement of water. Bloomberg New Energy Finance defines a small hydro project as a plant with a capacity of 50MW or less.
Marine	The marine sector covers all technologies relating to extraction of energy from the sea. Possibilities include waves and tide, either via tidal barrages or tidal flow generators. Note that exploitation of marine biomass would be categorised in biomass, rather than in this sector.
Geothermal	The geothermal sector covers technologies used to produce electricity from heat in deep subsurface geological formations. This heat can be extracted as part of a naturally occurring hydrothermal resource, or as an engineered geothermal system (EGS), which holds much potential but is still in early development stages. Exploration, drilling, and power plant technologies are all critical to geothermal resource development.

Table A.2 Summary statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
FIT generosity	760	0.105	0.165	0	1
FIT generosity adjusted	706	0.159	0.253	0	1
REC generosity	760	0.227	0.272	0	1
GWh ratio (tar,/acq.)	620	2.883	8.339	0.007	98.852
GDP ratio (tar./acq.)	700	2.314	6.958	0.014	116.251
Difference in R&D intensity	616	0.000	0.015	-0.085	0.180
Difference in investor protection	738	0.192	1.351	-4.7	5.3
Wind energy	760	0.478	0.500	0	1
Dummy Technological deal	760	0.091	0.287	0	1
Diversification	760	1.771	1.128	1	6