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Renewable energy investments - a panel data study of public policy influence in developing and emerging countries

Annika Berghäuser (40974)

Abstract

The aim of this thesis is to examine how public policy measures can induce investment in renewable electricity-generating capacity in developing and emerging markets. Using a novel combination of datasets for the time frame 2000-2014 and adopting a panel corrected standard error estimator, it tests the impact of economic and regulatory instruments, as well as policy support, on newly installed generation capacity. It is one of the first empirical studies to focus specifically on the investor perspective in evaluating public policies in emerging and developing renewable energy markets. The unique policy dataset has been self-constructed and encodes policy information on 50 sample countries. The results indicate that technology-specific policies are recommendable and that not all policies promote investments. The study thus provides a basis for the design of policies to close the renewable energy financing gap in developing and emerging countries.

Keywords: renewable energy, finance, investors, policy instrument choice, developing and emerging countries

JEL: C23, H25, H81, N7, Q42, Q48, Q58

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1 Introduction

As the IPCC Report (2014) highlights, extreme weather events as well as CO_2 levels have been rising in both developed and developing countries in recent years. To tackle climate change the international community agreed to keep global warming well below 2°C at the 2015 Paris Climate Conference (COP21). By universally adopting the Paris Agreement all parties of the UN Framework Convention on Climate change eventually sent a policy signal anticipated by many private sector actors.

At the same time the International Energy Agency (IEA, 2015) estimates a 33% growth of world energy demand by 2040, in which net growth can be entirely attributed to developing countries. Especially electricity demand is strongly correlated with economic growth (Yoo & Lee, 2010). The sub-Saharan power generation system alone is forecasted to quadruple in size to reach 385 GW by 2040 (IEA, 2014), Indian electricity demand will more than triple (IEA, 2016) and many more non-OECD countries are predicted to follow this trend. Moreover, globally a total of 1.1 billion people still lack access to electricity (SE4All, 2016).

However, generation of electricity and heat accounts for at least one quarter of all global greenhouse gas emissions (IEA, 2015). Thus, providing electricity access for all, while simultaneously keeping the commitments made under COP21, becomes a challenge. In line with the Sustainable Energy for All initiative's quest for universal energy access by 2030, renewable energy therefore forms a core pillar of the "Affordable and Clean Energy" Goal #7 of the new UN Sustainable Development post- 2015 agenda (UNSDG, 2017).

The expansion of renewable energies as a solution to both increasing energy demand and climate imperatives has already been extensively explored and discussed (Jefferson, 2008; Asif & Muneer, 2007), but the question of how public policy measures can channel private funds in this direction has not. Since government funds in developing countries are particularly limited, private sector investors have a major role to play in the implementation of the Paris Agreement if these countries are supposed to leapfrog into low-carbon economies (Mathews, Kidney, Mallon, & Hughes, 2010). Next to providing the necessary financial resources for investments in renewable energy, pivotal expertise and skills for construction and operation of large scale renewable energy plants also lies largely within the private sector. Hence, it is crucial for governments to mobilize the private sector to deploy technology, develop the required infrastructure and also finance its operation, if they want to meet their renewables targets (UNEP, 2012).

In the body of theoretical and qualitative literature it is usually assumed that renewable energy policy incentives are essential for the deployment or renewable generation capacity. Nevertheless, empirical evidence is mostly confined to EU and OECD countries (Polzin, Migendt, Taeube & von Flotow, 2015a; Cardenas Rodriguez, Hascic, Johnstone, Silva & Ferey, 2014; Marques & Fuinhas, 2012; Popp, Hascic & Mehdi, 2011), without conclusive proof for less developed countries. A recent paper by Romano, Scandurra, Carfora and Fodor (2017) ventures into this field and focuses on comparing the impact of green policies in developing and developed countries. Their research implies that it is likely that renewable energy policies have different impacts depending on a country's level of development. Hence, it is worthwhile to close the existing literature gap and to explore the effectiveness of public policy measures on the promotion of investments in emerging renewable energy markets, as identified by Climatescope (2016), in more detail.[1]

The novelty of this thesis lies in its focus on the analysis of a new set of countries in combination with the investor perspective and the subsequent choice of relevant control variables such as the financial market development, corruption level or contract enforcement. Furthermore, it is the first time that the Bloomberg New Energy Finance and the self-constructed IEA policy datasets have been combined for these countries, while the time series is also more recent than the one of Polzin et al. (2015a). By extending previous work on renewable energy investment behavior (Masini & Menichetti, 2013; Wüstenhagen & Menichetti, 2012), this thesis aims to add to the current academic debate on renewable energy policy support by developing policy implications. The main objective is to offer an empirically motivated analysis of renewable energy investments in developing, as well as emerging countries and link the choice of public support policy thereby to the development stage of the renewable energy market. This is of utmost importance so that governments might choose the appropriate policy support, economic and regulatory instruments. Thus, this thesis investigates in how far policy measures have encouraged renewable energy investments in developing and emerging countries and accordingly explores this relationship over time with a panel approach. The panel comprises 46 countries over a fifteen- year period (2000 – 2015) in the low to upper middle-income group within emerging renewable energy markets.

The thesis follows the call for research of Polzin et al. (2015a) by amending their policy analysis to another economic country grouping. It is structured in the following manner: After the introduc-

[1] The Climatescope initiative of US Aid, UK Aid and Bloomberg New Energy Finance assesses the conditions of renewable energy markets in 58 emerging countries in Latin America, Africa, Asia and the Middle East.

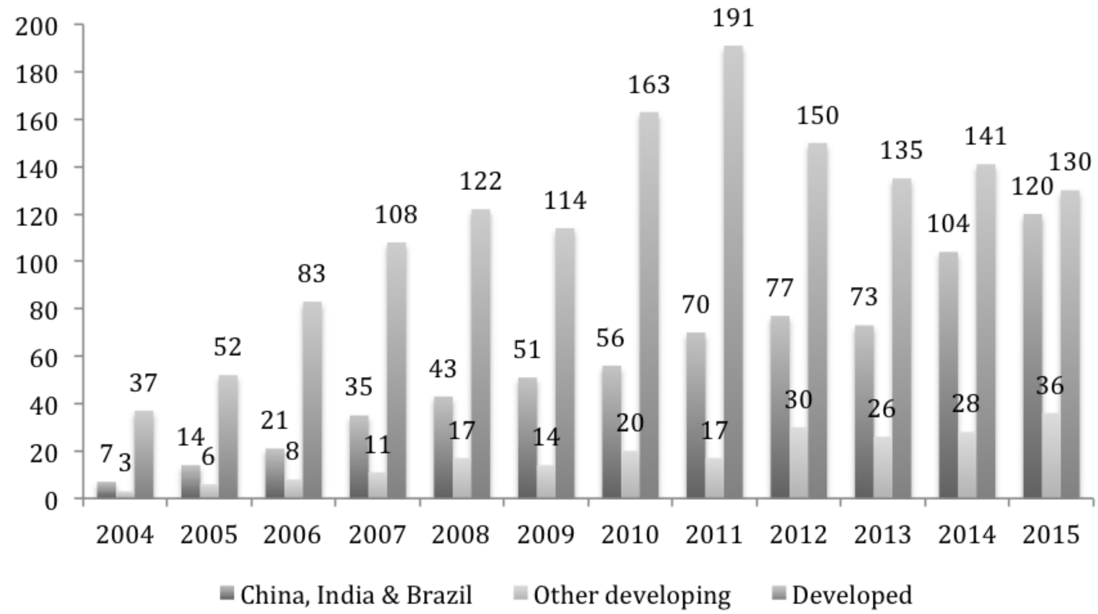
tion, Section 2 sets the research context and reports the current status of renewables and policies in emerging and developing countries. Section 3 introduces the specific policy measures considered in the analysis. Next Section 4 offers a review of the relevant literature concerning investment barriers for renewables in these markets and renewable energy promoting public policies respectively. Section 5 describes the construction of the novel dataset and the empirical methodology employed for the data analysis, as well as its limitations. It is followed by Section 6 with a presentation and discussion of the main findings, while Section 7 highlights the final conclusions and further research avenues.

2 Research Context - Current Status

2.1 Renewable Energy Investments

Throughout the years investments in renewable energy have been growing not only in developed countries but also in developing ones. The relative importance of developing countries in the growth of renewables investment seems to have finally manifested itself in 2015, when the Climatescope countries cumulatively attracted more investment ($154.1bn vs. $153.7bn) and witnessed far more clean energy capacity addition (69.8 GW vs. 59.2 GW) than OECD countries (Climatescope, 2016). Even though China and the other BRICS countries were largely responsible for this turnout, lesser-developed countries also contributed their part. In comparison to 2004, twelve times more was spent on renewable energy in developing countries excluding China, India and Brazil with investments reaching an all-time high of $36 billion. (see Figure 1) Other developing countries, which recently exhibit major investments, are South Africa, Mexico, Chile, Turkey and Uruguay (Frankfurt School-UNEP Centre, 2016).

Figure 1: Global New Investment in Renewable Energy: Split by Type of Economy, 2004-2015, $BN

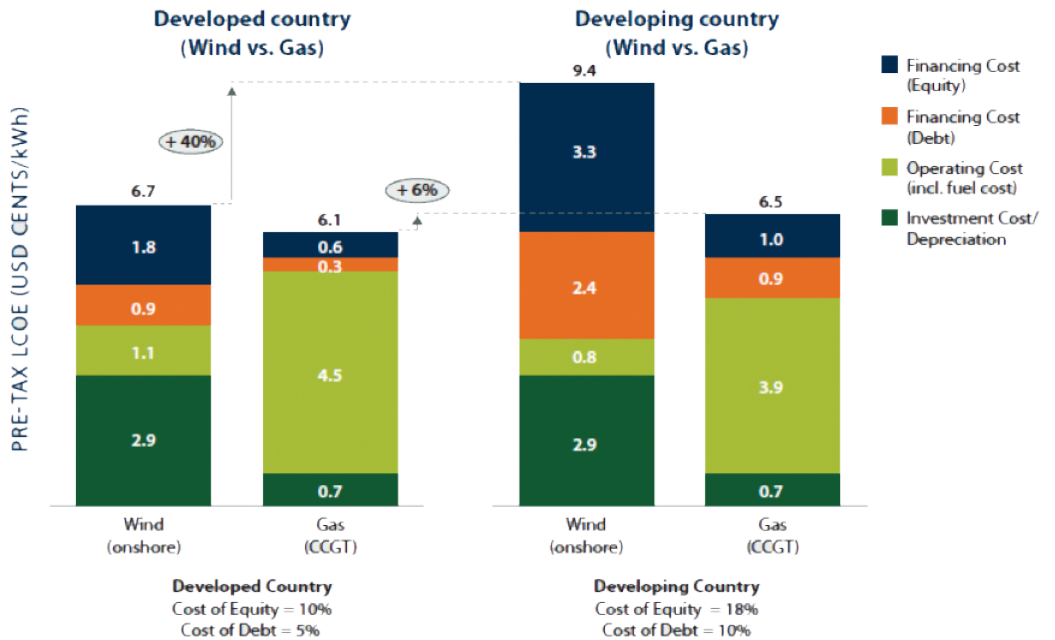


Source: Author's rendering of Frankfurt School-UNEP Centre/BNEF data (2016)

Furthermore, a new overall investment record of nearly $286 billion was reached in 2015, implying that for the first time the majority of all added power generation capacity came from renewables. Nevertheless, the challenges to keep global temperature increases below 2°C remain substantial and necessitate a major investment shift within the energy sector. The International Energy Agency estimates that the $40 trillion in cumulative energy investment in this scenario will clearly have to move farther towards renewables and other low carbon investments, with the fossil fuels' share dropping to only one-third by 2040 (IEA, 2016).

Although benefits of renewable energy generation for society are evident in the long term, private sector investors will only engage in projects in line with their immediate financial interest. For commercial electricity generation in developing countries conventional fossil fuel- based technologies are often still cheaper and easier to implement due to their lower capital-intensity or persisting subsidies for fossil fuels (UNEP, 2012). A common approach to compare the generation costs over the lifetime of various energy technologies is to calculate the levelized cost of energy (LCOE). Although the LCOE for renewables has been steadily decreasing and continues to decrease over time, the costs and returns on investment are still a limiting factor to their widespread construction.

Figure 2: Impact of Financing Costs on LCOE of Wind and Gas Projects



Source: Waissbein et al., 2013

Waissbein, Glemarec, Bayraktar & Schmidt (2013) identify two main components of LCOE; technology costs and financing costs. Technology costs include investment costs adjusted for depreciation and operational costs, whereas financing costs would refer to the cost of equity and debt. As can be seen in Figure 2 above the comparatively higher cost increase for renewables in developing countries is to be attributed to the differential in financing costs.

Thus, it is argued that governments must via the help of public incentive mechanisms and de-risking instruments create a "level playing field" and make renewable energy investments financially more attractive to competitive financial markets in order to close the large financing gap for renewables (Schmidt, 2014; Waissbein et al., 2013). Primary reasons for the difficulty of raising capital for renewable energy projects are their high up-front investment costs coupled with long pay-off periods in relatively high uncertainty environments. The resulting unfavorable risk-return profiles make them hard to finance particularly in developing countries (UNEP, 2012). Therefore, main stakeholders financing renewables in developing countries are still often governments, energy developers that are predominantly state-owned energy companies, and national or multilateral development banks (Polzin, von den Hoff & Jung, 2015b; SE4All, 2016; IRENA, 2012). However, mainstream financing as well as innovative financial instruments are also expanding into developing country markets, since investors try to capture higher yields at the expense of higher risks (REN21, 2016).

According to Mercator (2016) the aggregate internal rate of returns for solar projects for example are 28% higher in developing countries than in North America and Europe. (see Table 1) This is largely due to the bigger project size of utility- scale investments in these markets compared to smaller-scale solar installations in developed countries. Furthermore, market maturity and fierce competition keeps returns lower in Europe and the numerous risks in developing and emerging markets make projects less attractive for development, thus push returns higher.

Table 1: Average Unlevered IRR (%)

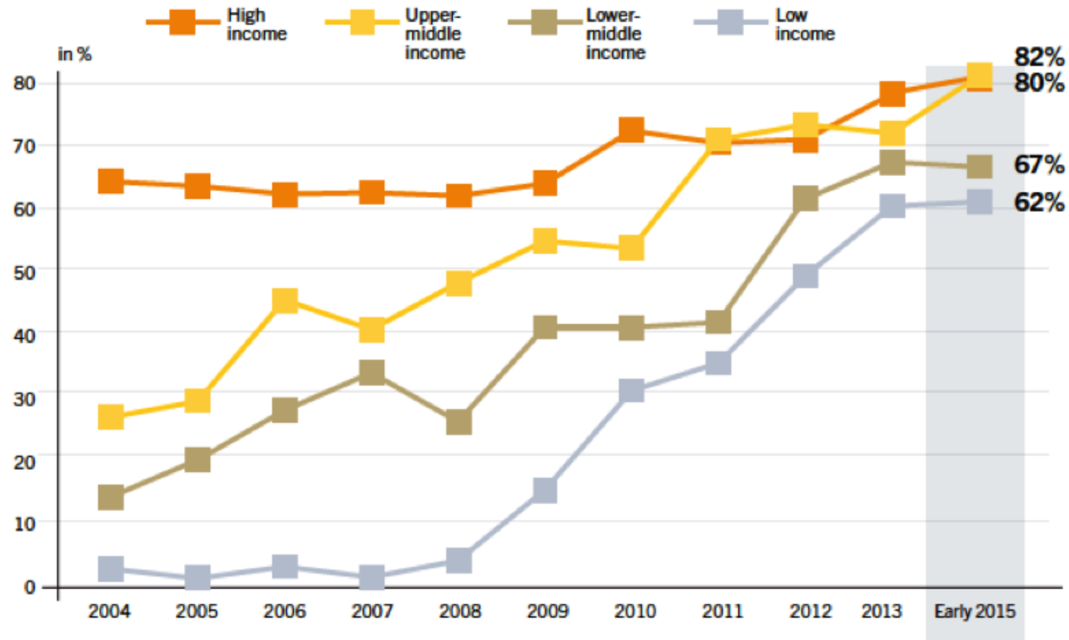
Region	**IRR %**
Europe	4,0
N. America	8,2
C. America	6,4
S. America	9,3
Africa	10,3
Middle East	10,4
Asia	8,4
Oceania	7,3

Source: Mercator, 2016

2.2 Adoption of Public Policies

Next to technological improvements and cost reductions, the growth of renewables has been accompanied by a surge in energy policies. To reduce risks and improve conditions for private investment in renewable energy, a wide range of public policy measures has been put in place in various countries. At the end of 2015, the vast majority of countries worldwide, 146 in total, had initiated renewable energy supporting policy incentives. An even higher number of 173 had at least stated renewable energy targets (REN21, 2016). While the share of countries with renewable energy policies differs from one income group to the next, less developed countries have clearly been catching up in the last decade. (see Figure 3)

Figure 3: Share of Countries with Renewable Energy Policies, by Income Group, 2004- early 2015



Source: REN21, 2015

This highlights very well the central importance governments attribute to the expansion of renewable energy generation also in developing and emerging countries. The policy measures aim to directly or indirectly impact the risk return structure of renewable energy projects and are thus meant to induce private investment.

3 Overview Public Policy Measures

The following section defines technical terms and gives an overview on the policy categories focused on in this study: economic instruments, policy support and regulatory instruments. It elaborates on their sub-categories and describes the underlying mechanisms.

3.1 Economic Instruments

Direct Investment – Infrastructure

Direct investments of public funds to improve the energy infrastructure are further considered in this research, as they are the most frequent form of direct investment in the countries studied.

Inadequate or antiquated grid infrastructure can cause limitations in transmission. Direct infrastructure investment in this context refers mainly to grid expansion and electrification efforts, which are thought to be conducive for investment and the deployment of renewable energy.

Tariff- based mechanisms

Feed- in tariffs (FiT) and auctions, both tariff- based mechanisms, offer a transparent support level via a guaranteed electricity price and thereby reduce the perceived investment risk (Menanteau, Finon & Lamy, 2003). By locking in an electricity sales price for a fixed period of time these measures can provide a higher security to investors on future cash flows. Although most of the FiT policies are market independent due to their fixed or minimum price, some market dependent FiT policies exist which only pay a premium over the market rate (Chang, Fang & Li, 2016). According to the REN 21's Global Status Report 2016 the most commonly used renewable capacity promoting policy tool are feed- in tariffs, which have been introduced in 110 jurisdictions.

Furthermore, capacity auctions, another tariff- based mechanism, are increasingly popular especially across developing and emerging countries. In contrast to price driven feed-in tariffs, auction-based tariffs are quantity driven with predetermined capacity amounts to be awarded (Becker & Fischer, 2013).[2] In 2009 only nine countries had auction schemes in place, but in early 2013 this number had already grown to 44, including 30 developing countries. Key drivers for their uptake are the inherent advantages of cost- efficiency and regulatory considerations such as local content requirements and location priorities. However, since tariff levels are determined through a competitive bidding process, this mechanism bears the risk of awarding capacity to financially not sustainable bids leading do project delays or even failures (Lucas, Ferroukhi & Hawila, 2013).

The preferences for each of the tariff- based instruments differ across governments with some implementing either or and others relying on both. Nevertheless, the consequence is the same for the investor; both times the project secures a long-term power purchasing agreement (PPA) at a fixed price. Recognizing thus that the only clear distinction between PPA-based bidding processes/ auctions and FiTs is the way of determining the payment level, this study merges both in one tariff-based mechanism variable.

Tax Incentives

Tax incentives or exemptions can be implemented in various forms and are a flexible policy measure which is often complementary to other public policies. Some are designed as investment tax credits

[2]Consult for comparative discussion on auctions and FiTs in non-OECD countries.

or accelerated depreciation to reduce the tax obligations of firms invested in renewable energy projects and as a consequence attract firms in this sector (Chang et al., 2016). Also value- added or import tax rebates and reliefs on equipment, which are both very prominent in the analyzed country set, aim at reducing the cost of investment.

Other tax incentives are related to production and mostly calculate the tax credits or income tax deductions annually based on the amount of renewable electricity generated, thus reducing the operational cost (De Jager et al., 2011).

Grants, Subsidies, Loans & Guarantees

Public sector resources can support renewable energy investment decisions through grants, low-interest loans and loan guarantees (Abdmouleh, Alammari & Gastli, 2015). Grants are a way of financial assistance given out by the government for specific projects, which do not have to be payed back. Just as low-interest loans with rates below the market interest rate and loan guarantees, they aim to decrease the initial investment burden of renewable energy projects.

3.2 Policy Support

The risk concerning policy continuity and governmental commitment explains the need for policy support instruments, including strategic planning as well as institutional creation. Both do not immediately influence the risk return structure of renewable investments but rather boost the confidence of market actors and set the necessary legal framework.

Strategic Planning

The basis for all further policy incentives is optimally formed by an overall national energy plan, which includes not only a strategy for the deployment but also integration of renewable energies. A key feature of these plans is the inclusion of an official national renewable energy target for a certain level of generation by a future date, often even including detailed shares per technology. The political signal governments send by implementing a target is a strong encouragement for the private sector, which can expect a cost reduction due to a better infrastructure base and increased production (Abdmouleh et al., 2015).

Institutional Creation

Specialised public institutions play an important role in the dissemination of information or promotion and enhancement of the renewables market. Especially at the planning and operational level exists a need for regulatory agencies to streamline processes in response to the liberalisation of energy sectors (Painuly, 2001). These can provide smooth bureaucratic processes.

3.3 Regulatory Instruments

Given the uncertainty surrounding the renewable energy market, an unambiguous regulatory framework and legal security can help to raise investors' interest. Regulatory measures usually relate to legal issues at the development, implementation and especially commercialization stage of renewable energy projects such as land use, permits, grid codes, grid access and finance issues.

Lengthy and uncertain processes to secure grid access and obtain permits for construction and operation are especially detrimental for investors and hence need regulatory attention. Since renewable energy projects tend to be decentralized, intermittent and often more small scale in comparison to conventional plants, obtaining market access is not always a smooth undertaking without respective legislation (Abdmouleh et al., 2015).

4 Literature Review

This section provides a review of relevant literature on barriers to renewable energy investment and public policies used to induce these, with a focus on emerging and developing countries.

4.1 Barriers to Renewable Energy Investments

The relationship between public and private finance concerning investments in renewable energy remains ambiguous (Cárdenas Rodríguez et al., 2014). However, there is a wide consensus on the vitality of getting private institutional investors on board for a successful energy transition (Mueller, Brown & Olz, 2011; Popp et al., 2011).

Multiple scholars have thus explored the decision criteria for investors. Bergek, Mignon and Sundberg (2013) identify overall portfolio cost, perceived market uncertainty and political risk as main determinants for investments, while economic and infrastructural obstacles are also highlighted in the literature (Painuly, 2001; Tsoutsos & Stamboulis, 2005).

Even though many of the developing countries have powerful development prospects with respect to economy, population and electricity, there are still barriers to unlocking private finance for the scale- up of renewable energy projects in these countries. In their review on drivers and barriers for renewable energy investments in emerging countries, Polzin et al. (2015b) identify the legal framework, the institutional environment, an overarching macro-economic stability and growth potential as the main factors to be considered.

4.1.1 Energy Market Structure

The energy sector of developing countries is still often heavily regulated and does not allow grid access to private sector actors on a competitive basis making it burdensome to deploy renewable energy technologies. According to Polzin et al. (2015b) early guidance in the integration process of renewables into the electricity system has been proven to be beneficial for project development in more mature markets. However, in environments historically dominated by state- owned utilities in monopoly positions and often vertically integrated supply chains, developing countries tend to lack enticement, as well as flexibility to provide smooth grid and market access (UNEP, 2012). Difficulties of entering national electricity markets and the absence of competition have been identified as big investment barriers for private sector independent power producers (IPPs), who are hindered to sell their electricity. Thus, the need for power sector reforms towards liberalization, privatization and consequentially higher decentralization has been highlighted in the literature (Pollitt, 2008; Bacon & Besant- Jones, 2001).

Additionally the design of power sectors in developing countries is prone towards political interference to guarantee low electricity prices. Further endangering the financial sustainability of power project developments, this circumstance thus stifles the willingness of private players to invest in renewable energy (Nagayama, 2009). The same holds for fossil fuel subsidies impairing the cost competitiveness of renewable energy generation, by lowering the cost of fossil fuels relative to renewable sources in countries such as Indonesia or Nigeria (Bridle & Kitson, 2014).

In comparison to developed countries, investors in developing countries not only face market access authorization challenges and possibly low energy prices, but also infrastructural hurdles such as high distribution losses, limited coverage and a lack of investment in the often-obsolete technology in general. It has been shown that poor electricity access and distribution losses (blackouts or electricity theft) discourage investment from the private sector (Friebe, von Flotow & Taube, 2014; Kessides, 2012).

4.1.2 Macroeconomic Hurdles

Literature points out the significance of currency risk for renewable energy investments in developing countries and its continued deterrence of large international private capital funds (Polzin et al., 2015b; IRENA, 2012; SE4All 2016).

Private investors face a higher real exchange risk due to fluctuations in nominal exchange rates and inflation (Bleaney, 1996). Since renewable energy projects are generating electricity, a public good, to the local population and businesses, the project's cash flows tend to be in local currencies while the debt service and dividend payments are usually denominated in U.S. dollars. Therefore, if foreign debt is used the project's returns are much more volatile in the investor's hard currency and private sector engagement might be restricted due to decreased project attractiveness (Nelson & Shrimali, 2014). This is a problem especially in less developed countries, which are mostly reliant on foreign investors for infrastructure projects considering their not sufficiently developed and unstable financial markets with a lack of technology know-how among local financial institutions (UNEP, 2012).

Accordingly, Brunnschweiler (2010) focuses on non-OECD countries when examining the role of the financial sector in renewable energy development. He can provide evidence that financial intermediation, particularly commercial banking, has a significant positive effect on the amount of renewable energy produced.

Cárdenas Rodríguez et al. (2014) highlight two distinct market failures, whose presence fosters difficulties in renewable energy project development. The first one is the above described capital market imperfection in the efficient allocation of capital, which makes it difficult to obtain financing. The second one concerns the fact that firms have not yet internalized environmental externalities of conventional power generation, such as CO_2 emissions (see also Aguirre & Ibikunle, 2014).

4.1.3 Regulatory and Political Risk

The investment decision for renewable energy tends to be subject to public incentive mechanisms and hence is directly dependent on effective law enforcement. Cárdenas Rodríguez et al. (2014) emphasize that considerable uncertainty concerning viability as well as level of a policy regime is a major investment constraint in imperfect capital market settings. This makes trust in the legal and regulatory frameworks implemented by policymakers in developing and emerging countries a crucial prerequisite for private sector investment activities. One of private investor's primary concerns is whether incentives are likely to stay in place over the life cycle of a renewable energy project. In developing countries this depends especially on the stability of legal systems and public institutions alike (UNEP, 2012).

Furthermore, corruption and transparency issues pose an additional source of risk and cost to project development in these countries. Through qualitative expert interviews Komendantova, Patt, Barras and Battaglini (2012) identified the main risks perceived for deployment of concentrated solar power in Northern Africa. These are regulatory risks (including corruption and complex bureaucratic procedures), political risk (including political instability) and force majeure risks (including terrorism).

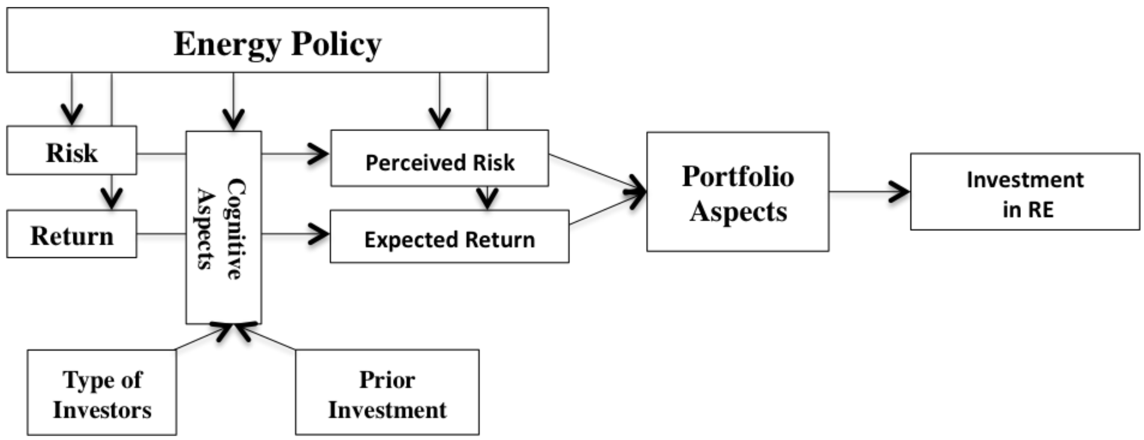
Although generally speaking all infrastructure projects with private sector involvement in developing countries entail some degree of political and regulatory risk, renewable energy projects supplying a public good are especially vulnerable. Due to the nature of many electricity sectors in the developing world, investors must directly deal with state-owned utilities and often numerous other types of public institutions. Multiple scholars therefore identify regulatory risks and the streamlining of administrative processes for a successful grid access as substantial considerations in the investment decision-making process (Friebe et al., 2014; Lüthi & Prassler, 2011; Lüthi & Wüstenhagen, 2012).

Further, the risk of expropriation, war or civil disturbance in politically less stable regions will eliminate projects early on in any financial decision- making processes making it harder to attract private financing for otherwise viable projects (Baldwin, 2006).

4.1.4 Risk- Return Profiles

The risk- return profile of renewable energy projects has been recognized as highly important investment evaluation criterion (Cárdenas Rodríguez et al., 2014; Dinica, 2006). Wüstenhagen and Menichetti (2012) also explain the level of renewable energy investment with a simplified model in which investment is a function of risk and return, which vice versa are influenced through policy. Investment opportunities are accordingly chosen based on the best return for a given level of risk. The scholars extend this model by considering portfolio diversification effects, investor segmentation, path dependence and insights from behavioral economics about bounded rationality. (see Figure 4)

Figure 4: Differentiated Model of Renewable Energy Policy and Investment



Source: Wüstenhagen & Menchetti (2012)

Regulatory and macroeconomic risks are raising the return expectations of private renewable energy investors in developing countries. Furthermore, banks tend to only offer shorter loan terms and increase the equity requirements to manage their lending risk in developing countries (Shrimali et al., 2013; Waissbein et al., 2013).

Consequentially in theory viable and financeable infrastructure projects may not be realized. The relationship between lower risk and lower financing costs for renewable energy projects through the cost of capital for investors has further already been pointed out by De Jager and Rathmann (2008) or Wiser and Pickle (1998), who find that financing processes are often ignored or misunderstood in the design and implementation of renewable energy policies.

Generally long-term investment horizons are decisive with regards to renewable projects due to their high upfront costs and capital intensity. Hence, a growing body of literature discusses their suitability for institutional investors, like insurances, pension funds or banks (Nelson & Pierpont, 2013; Klaminker & Stewart, 2012). Renewable energy project's long-term, stable cash flows turn them into potentially attractive investment opportunities in developing countries (Urban, Benders & Moll, 2007).

4.2 Public Policy Influence on Renewable Energy Deployment

The necessity of public intervention for the promotion of renewable energy investments is widely agreed on in the literature. In the absence of renewable energy incentives, the probability of a technological lock-in would be likely as renewable energies up to this day are not always cost competitive with conventional energies due to their still relatively early diffusion phase (Dinica, 2006; Foxon & Pearson, 2008).

Hence, a multitude of economic, regulatory and policy support measures have been applied over the years, across jurisdictions and renewable energy technologies. However, statistically significant differences in the number of policies adopted to promote investments in renewable energy remain across country groups. Developed countries adopt on average 4,8 policies, while developing ones only adopt 3,5 (Romano et al., 2017). This is not necessarily a bad sign though, because a larger number of policies does not automatically bring about stronger policy effects. Research confirms a diminishing or even conflicting effect of public policies on renewable electricity generation (Zhao, Tang & Wang, 2013).

Abdmouleh et al. (2014) deliver a comprehensive analytic survey on renewable energy integration support systems. They classify these according to financial, fiscal, legislative, political, technological or environmental aspects and report lessons learned from international case studies.

Although a policy mix of economic, policy and regulatory instruments appears to be the best way forward, it is hard to identify any consensus in the literature. Marques, Fuinhas and Manso (2010) distinguish country-specific, socioeconomic and political determinants of renewable energy deployment, but do not include policy variables in their research. In a subsequent study, Marques and Fuinhas (2012) empirically test the impact of public policies on a large panel of European countries and identify them as significant drivers of renewable energy projects. Polzin et al.'s (2015a) analysis of OECD countries calls for technology specific policies and suggest that regulatory measures and long- term strategic planning positively influence the renewable energy investment climate. Their results show that economic and fiscal instruments are particularly recommendable for less mature technologies. The empirical results of Zhao et al. (2013) for 122 countries suggest that renewable energy policies have a positive and significant impact on the sector's development. However, the effect diminishes, as more and more renewable energy policies are deployed and is more pronounced in developed and emerging market countries. Further, the negative policy interaction effect decreases with the stage of economic development, possibly due to better institutions and richer experience in renewable energy policy formulation. In a recent paper, Romano et al. (2017) confirm that not all policies promote investment in renewable energy and effectiveness depends on the respective country's development stage. They show that developed countries should favor regulatory policies, developing ones in contrast should rather choose policies with greater state intervention.

This is partially in line with Aguirre and Ibikunle (2014), who control for political, socioeconomic and country- specific factors and find no significant effect for renewable energy policies across OECD, EU and BRICS countries. Their results even suggest that fiscal and voluntary instruments are negatively related to the growth of renewables in the energy mix.
Further qualitative literature concerns the drivers and barriers for renewable energy diffusion in emerging countries (Polzin et al., 2015b; Becker &Fischer, 2013).

4.2.1 Economic Instruments

Market- based instruments can be used to spur investments in renewable energy projects. Researchers giving preference to instruments such as carbon cap and trading systems (Helm, 2002; Rogge, Schneider & Hoffmann, 2011; Smith & Swierzbinski, 2007) or green certificates (Jensen & Skytte, 2002; Szabo & Jaeger- Waldau, 2008) mostly rely on carbon and energy market liberalization arguments. Nevertheless, multiple authors have also discovered implementation limitations of trading schemes along the lines of transaction costs and market power (Jensen & Skytte, 2002; Menanteau et al., 2003; Bergek & Jacobsson, 2010).

Moreover, further economic instruments not dependent on market prices include financial and fiscal instruments. One possibility to spur the deployment of renewable energy is direct public investment in complementary infrastructure (Steinbach, 2013) or directly in renewable energy projects. Cárdenas Rodriguez et al. (2014) for example find that developing countries have a higher share of public co-financed projects than OECD countries. While evidence for a substitution effect of public finance exists, they argue that this should not be interpreted as a crowding- out of private finance, but rather as means of securing project completion of projects with difficulties of attracting sufficient private investors. Also Wüstenhagen and Menichetti (2012) point out that governments provide funding to prevent financing gaps.

Issues on the capital supply side including financial institutions, financial markets, financial tools and business models, are further addressed by subsidies, preferential loans with low interest rates and grants. Chang et al. (2016) argue that these policies have the potential to improve profitability and thus the availability of funding since project developers raise as much capital as possible from the cheapest source before moving up to the next tiers. However, Shen and Luo (2015) find that subsidy policies tend to have only short-term positive effects.

There are numerous members of the scientific community who advocate that tariff-based measures are best suited for promoting renewable energy investments and ensuring technological diversity (Ragwitz et al., 2007; Couture & Gagnon, 2010). Bürer and Wüstenhagen (2009) confirm this perception in their survey conducted with 60 investment professionals from European and North American venture capital and private equity funds. While the desired reduction of risk from an investor's perspective is evident, FiTs have also attracted criticism for their public cost implications particularly in the PV field (Frondel, Ritter & Schmidt, 2008). Further, Popp et al. (2011) do not find a significant effect of either FiTs or renewable energy certificates for wind in their statistical analysis on country level. Also FiTs seem to lose some of their driving force in the industry over time. This is one of the findings of Romano, Scandurra and Carfora (2015), who estimated the probability that countries introduced a FiT under differing scenarios making use of a panel probit model. Furthermore, Cárdenas Rodriguez et al. (2014) find that higher FiTs are correlated to higher private investment amounts only in OECD countries.

Literature also analyzes the impact of fiscal incentives, focusing on tax relief and tax credit systems (Barradale, 2010; Bird et. al, 2005; Cansino, Pablo-Romero, Román, & Yñiguez, 2010; Quirion, 2010). The results of Cárdenas Rodríguez et al. (2014) suggest a positive effect of tax relief/ tax credit measures, in relative magnitude they find them to have the same effect as a 6.6% raise in feed-in tariff payments. The counterintuitive result of other studies is that these fiscal incentives are sometimes rather negatively related to renewable energy deployment (e.g. Aguirre & Ibikunle, 2014). Johnstone, Hascic and Popp (2009), who examined the effect of policy incentives on patents per technology, explain this with the missing investor confidence in public budget dependent policies, as they tend to be renounced during administration changes and consequentially are less likely to persist over time. The American production tax credit system for wind projects, which experienced repeated expiration and renewal, exemplifies this situation via the boom-bust cycles created by uncertainty in the sector (Barradale, 2010).

Finally, the dependence upon public budgets of both tariff-based, as well as tax- based mechanisms, could have a negative impact on their viability over time during economic crisis. Contrary to this market- based instruments are more independent of public budgets, but exhibit higher price volatility as consequence. Being aware of this uncertainty trade- off for investors between level and viability of support is crucial for designing policy regimes, which induce private finance flows (Cárdenas Rodriguez et. al, 2014).

4.2.2 Policy Support

Consequently, previous research shows that investors highly value long-term strategic frameworks and renewable energy targets, since they indicate the level of a government's ambition and vision (Polzin et al., 2015a; White, Lunnan, Nybakk & Kulisic, 2013; Lüthi & Wüstenhagen, 2012; Marques & Fuinhas, 2012). Furthermore, they also imply policy consistency and predictability, both indispensable in ensuring profitability of on-going investments as well as making the further exploration of new projects attractive. Lund (2007) emphasizes the need for a strategy to integrate renewable energy plants into coherent energy systems. Closely related to the political will is also the creation of responsible institutions, which demonstrates policy commitment. The only study encountered with conflicting results is by Pfeiffer and Mulder (2010), who find that attention to institutional creation and strategic planning have a negative effect on the diffusion of renewable energy technology in developing countries. They explain this counter intuitive relationship between policy support and renewable energy diffusion by the fact that governments in these countries often exhibit weak institutions with low levels of human capital, patronage- based processes and a lack of strong democratic control mechanisms. Moreover, dependency on a variety of donor organizations sometimes makes policy formulation and implementation in developing countries very complex. Frequently official policy programs and execution by actual officials diverge considerably (Mulder & Tembe, 2008).

4.2.3 Regulatory Instruments

Generally, authors have identified regulation to be a major factor in inducing the uptake of clean technologies in industrial sectors (Gray & Shadbegian, 1998; Popp, 2009).

Concerning renewables, the results on the impact of regulatory measures such as energy obligation schemes, codes and standards, energy audits of industrial facilities or any other mandatory requirements is mixed though. Marques and Fuinhas (2012) report them not to be relevant yet in stimulating renewable energy uptake. However, in Menz and Vachon's (2006) research they do show a positive effect, although not as effective as FiTs. Pfeiffer and Mulder (2013) even suggest a stronger effect of regulatory instruments than economic instruments in developing countries, as they are not as intangible as policy support measures.

5 Research Method

The aim of this thesis is to analyze the influence of public policy measures on investments in renewable energy generation capacity in emerging and developing countries. This is operationalized through a panel data regression covering 46 Climatescope countries throughout the time period 2000 to 2014. The selection of the variables for the model is based on previous literature on the topic.

First, the section presents the model and its components. Second, it introduces the dependent and independent variables and explains how the unique policy dataset was encoded. Third, the section discusses the validity of the control variables and then elaborates on the econometric research strategy in the following. Finally, a variety of alternative model specifications are reported to test the robustness of the model and limitations are presented.

The impact of public policies on renewable energy investments is assessed by specifying the following estimation regression:

$$REC_{j,k} = \alpha_0 + \sum_{i=1}^{i} \beta_i PM_{ijk} + \sum_{m=1}^{m} \gamma_m CV_{mjk} + d_j + d_k + \epsilon_{j,k}$$

where,

$REC_{j,k}$	Aggregated additions to generation capacity per country j and per year k
$PM_{i,j,k}$	Vector of $i = 8$ explanatory policy measures per country and year
$CV_{m,j,k}$	Vector of $m = 8$ control variables per country and year
d_j	Dummy variable country used to capture time-invariant heterogeneity
d_k	Dummy variable time used to capture time-variant global shocks
$\epsilon_{j,k}$	Regression error

This specification of the estimation regression does not prevent that some control variables, such as income do potentially affect policy measures. Simultaneously, the set of control variables may be missing factors, which could also affect renewable energy policies. Nevertheless, the presented modeling framework is appropriate since the study is interested in the effect of policies on the investor's decision to develop renewable energy projects and not in the drivers of renewable energy policies.

Table 2: Variables Definition

	Definition	Source
Dependent Variable RECj,k		Bloomberg New Energy Finance,
BNEF_Capacity_Windjk	Logarithm of capacity additions of wind in MW	Asset Finance Data
BNEF_Capacity_Solarjk	Logarithm of capacity additions of solar in MW	
BNEF_Capacity_Biojk	Logarithm of capacity additions of bioenergy in MW	
BNEF_Capacity_Hydrojk	Logarithm of capacity additions of hydro in MW	
BNEF_Capacity_Alljk	Logarithm of capacity additions of multiple RE technologies in MW (wind, solar, bioenergy, hydro, geothermal)	
Independent Variables PMijk	Accumulated number of RE policies (ANP)	IEA/IRENA Global RE Policies and Measures Database; Climatescope
Economic Instruments		
Tax Incentives	Logarithm of ANP (tax reliefs and taxes)	
Tariff-based Mechanisms	Logarithm of ANP (Feed-in tariffs/premiums and auctions)	
Direct Infrastructure Investment	Logarithm of ANP (direct infrastructure investment)	
Grants and subsidies	Logarithm of ANP (grants and subsidies)	
Loans	Logarithm of ANP (loans)	
Policy Support		
Strategic Planning	Logarithm of ANP (strategic planning)	
Institutional Creation	Logarithm of ANP (institutional creation)	
Regulatory Instruments	Logarithm of ANP (all regulatory measures combined)	
Control Variables CVmjk		The World Bank
Income	Logarithm of GDP per capita (constant 2010 US$)	World Development Indicators
FDI	Foreign direct invest., net inflows (% of GDP)	World Development Indicators
Total Electricity Consumption	Logarithm of electric power consumption (GWh per capita) *population	World Development Indicators
Energy Intensity	CO2 emissions (kg per 2010 US$ of GDP)	World Development Indicators
Energy Dependence	Energy imports, net (% of energy use)	World Development Indicators
Fin. Market Development	Domestic credit to private sector (% of GDP)	World Development Indicators
Corruption	Corruption Perceptions Index	Transparency International
Contract Enforcement	Ease of Doing Business Index (Contract Enforcement Category)	The World Bank

5.1 Data

The following section presents the data used for the dependent and independent variables in this study. In total 50 Climatescope countries, excluding China, India and small island states, with different political, social and economic characteristics are examined (Appendix Table A1). Although the countries all exhibit unique characteristics, they all fall within the low and middle-income bracket. The unique dataset analyzed has been compiled using data from multiple sources as explained in the following.

5.1.1 Dependent Variable

Numerous studies (Romano et al., 2017; Aguirre & Ibuikunle, 2014; Zhao et. al., 2013; Marques & Fuinhas, 2012) choose to measure the dependent variable as contribution of renewable energy to total energy supply. The choice of a percentage in contrast to an absolute number can be explained by the research angle of the papers. Some are motivated by climate concerns, for which the primary goal is not only to increase renewables but also to simultaneously decrease the use of fossil fuel based technologies. Others focus on judging the overall effectiveness of policy measures, which often are designed to target specific renewable energy generation rates.

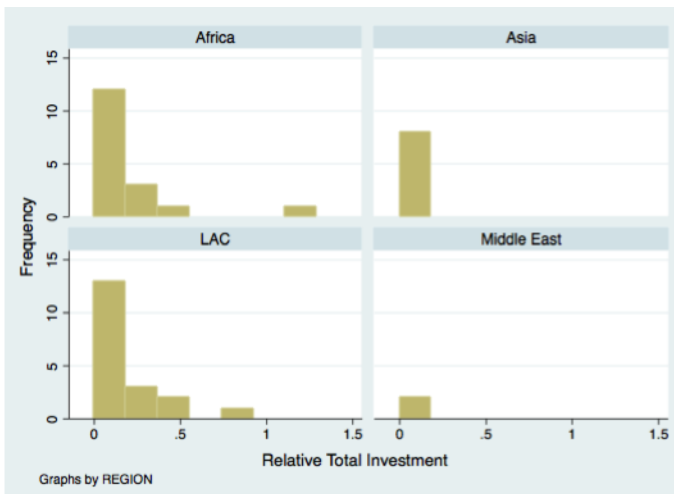
This thesis takes the investor's perspective and aims to solely study the policies' effectiveness in promoting renewable energy investments. Thus, it follows Polzin et al.'s (2015a) approach and chooses to measure the dependent variable in absolute terms of newly taken renewable energy investments. Moreover, since many developing and emerging market countries can be characterized through a growing energy demand and thus also growing overall capacity, a proportional measure seems inadequate to capture the taken renewable energy investments. However, by including the total electricity consumption as control variable this model accounts for differences in the electricity market size.

Investments measured as additions to renewable energy capacity (>1MW) were extracted from Bloomberg New Energy Finance (BNEF), which is one of the most comprehensive data sources of clean technology energy finance available (Cárdenas Rodríguez et al., 2014). According to Popp et al. (2011) capacity indicators approximate the deployment of a technology best. Therefore, the dependent variable is constructed from the aggregated investment decisions on generation capacity (in MW) in a respective country, for each year (date of financial close) and technology e.g. wind, solar, biomass, hydro and geothermal. Choosing the time of the investment decisions for the analysis in contrast to the more traditional ex-poste analysis of installed capacities may bring new insights, since the construction period is not relevant in this case.

Many studies exclude hydroelectric generation from their analysis, because it is being increasingly viewed critically due to negative environmental and social externalities (Brunnschweiler, 2010). However, the BNEF database allows one to consistently distinguish large and small hydropower projects and thus this study is able to include only small hydro investments (<50MW). Information from BNEF's asset finance section on the installed electricity generating capacity, geographic location, financial close date and technology has been used. The data contains in total 2264 investments, including 599 wind, 303 solar, 408 biomass, 885 hydro and 69 geothermal investments, which reached financial close in the years 2000-2015. Since at the point of extraction (Feb. 2017) the data quality from the most recent year is not guaranteed due to continuous updates, the year 2016 is excluded from the analysis. Moreover, the time frame is chosen as it covers the most substantial developments in the global renewable energy industry and since investments in renewable energy were fairly limited until the early 2000s, especially in non-OECD countries (Wüstenhagen & Menichetti, 2011).

Figure 5 shows the distribution of countries by the ratio of aggregate renewable energy investments between 2000 and 2015 as a share of the national total generation capacity in 2014. While the majority of countries (35) only had investments in renewables of less than 10% of the 2014 capacity, two regions have outliers. In Africa especially Rwanda could excel with more than 100% and also Kenya recorded investment over 2000-2015 that are equivalent to nearly 50% of its 2014 capacity. In Latin America Uruguay stands out with an investment ratio of 77%. Generally the figure visualizes that the investment performances vary considerably across countries and regions with most of them still exhibiting an underinvestment, when investment is measured against a country's generation capacity.

Figure 5: Distribution of Countries by Ratio of RE Investments as Share of 2014 Total Generation Capacity in MW, 2010-2015 (number of countries)



Source: Author's rendering of U.S. eia & BNEF data (2017)

5.1.2 Independent Variable

A novel policy dataset consolidated from the IEA/IRENA and Climatescope databases has been constructed through encoding policy information after careful study. It groups policy measures in the following three major categories: Economic Instruments (Direct Infrastructure Investments, Tariff- Based Mechanisms, Tax Incentives, Loans and Grants/Subsidies), Policy Support (Institutional Creation and Strategic Planning) and Regulatory Instruments (aggregated). The focus lies on economic and regulatory instruments in combination with policy support, since market-based mechanisms are not yet as common in non-OECD countries.

The public IEA/IRENA Policy and Measures database supplies the policy indicators for the majority of countries. These indicators have been used by prior academic research for the EU (Marques & Fuinhas, 2012), OECD member countries (Polzin et al., 2015a) and globally (Cárdenas Rodríguez et al., 2014; Aguirre & Ibikunle, 2014). For 8 countries not covered in the IEA/IRENA database, the Climatescope policy database is consulted.

The policy dataset has been constructed with binary policy variables, which signify the policy presence per country, year and sector. Since both databases record the policy implementation status ("in force", "ended", "planned" or "superseded"), it is possible to link a start and ending date to each policy. The binary variable then takes 0 as value prior to implementation and 1 thereafter for each of the policy measures.[3] In a number of cases, more than one of each type of policy was implemented over the panel's time frame. Thus, counting the respective active policies for each technology and year finally creates the key explanatory variable, accumulated number of policies.

Thereby, the methodology allows decomposing the effects econometrically and comparing the experience across multiple countries just as Romano et al. (2017), Polzin et al. (2015a) and Cárdenas Rodríguez et al. (2014) did by using this approach. This is an improvement to the policy variable construction of Aguirre and Ibikunle (2014), which only reflects the existence of different policy types and does not allow inferences concerning implementation years and eligibility of technologies.

Below the overall summary statistics for the main variables of interest are reported. Since sufficient variation in the explanatory variable is needed for a meaningful analysis, countries with less than 3 policies in total were dropped from the panel. These are Lebanon, Congo (Dem. Rep.), Cote d'Ivoire, the Dominican Republic and Liberia. Both the dependent and independent variables have a skewed distribution, therefore this study corrects for this by log- transforming the variables (Hair, 2010).

Table 3: Summary Statistics of Selected Variables by Technology Group

[3] Policies that went into force after November in a given year are coded as effective the following year.

Multiple RE

Variable	Obs	Mean	Std. Dev.	Min	Max
log_BNEF_Capacity	736	1.776	2.146	0	7.737
log_EI_DI_Infra_	736	.113	.284	0	1.099
log_EI_Tarif_Based_	736	.134	.305	0	1.099
log_EI_Grants_Subsidies_	736	.098	.261	0	1.386
log_EI_Loans_	736	.048	.183	0	1.099
log_EI_FI_TR_	736	.264	.395	0	1.386
log_PS_Institutional_	736	.168	.326	0	1.099
log_PS_Strategic_	736	.371	.481	0	1.792
log_RI_aggregate_	736	.334	.476	0	2.079

Solar

Variable	Obs	Mean	Std. Dev.	Min	Max
log_BNEF_Capacity	736	.275	.992	0	6.999
log_EI_DI_Infra_	736	.028	.137	0	.693
log_EI_Tarif_Based_	736	.096	.254	0	1.386
log_EI_Grants_Subsidies_	736	.02	.115	0	.693
log_EI_Loans_	736	.018	.117	0	1.099
log_EI_FI_TR_	736	.121	.273	0	1.099
log_PS_Institutional_	736	.017	.107	0	.693
log_PS_Strategic_	736	.087	.251	0	1.609
log_RI_aggregate_	736	.053	.21	0	1.609

Wind

Variable	Obs	Mean	Std. Dev.	Min	Max
log_BNEF_Capacity	736	.675	1.631	0	7.162
log_EI_DI_Infra_	736	.018	.11	0	.693
log_EI_Tarif_Based_	736	.106	.28	0	1.386
log_EI_Grants_Subsidies_	736	.041	.174	0	1.099
log_EI_Loans_	736	.022	.13	0	1.099
log_EI_FI_TR_	736	.097	.252	0	1.099
log_PS_Institutional_	736	.017	.107	0	.693
log_PS_Strategic_	736	.098	.269	0	1.609
log_RI_aggregate_	736	.059	.224	0	1.099

Bioenergy

Variable	Obs	Mean	Std. Dev.	Min	Max
log_BNEF_Capacity	736	.586	1.358	0	6.627
log_EI_DI_Infra_	736	.019	.113	0	.693
log_EI_Tarif_Based_	736	.106	.278	0	1.386
log_EI_Grants_Subsidies_	736	.036	.163	0	1.099
log_EI_Loans_	736	.026	.139	0	1.099
log_EI_FI_TR_	736	.031	.144	0	.693
log_PS_Institutional_	736	.019	.113	0	.693
log_PS_Strategic_	736	.092	.256	0	1.609
log_RI_aggregate_	736	.049	.194	0	1.099

Hydro

Variable	Obs	Mean	Std. Dev.	Min	Max
log_BNEF_Capacity	736	.944	1.597	0	6.648
log_EI_DI_Infra_	736	.024	.128	0	.693
log_EI_Tarif_Based_	736	.124	.289	0	1.386
log_EI_Grants_Subsidies_	736	.03	.152	0	1.099
log_EI_Loans_	736	.03	.147	0	1.099
log_EI_FI_TR_	736	.1	.26	0	1.099
log_PS_Institutional_	736	.017	.107	0	.693
log_PS_Strategic_	736	.085	.25	0	1.386
log_RI_aggregate_	736	.083	.256	0	1.386

5.2 Controls

In order to control for unobserved heterogeneity, time and country dummies are included in the analysis. These take care of differences in the dependent variable attributable to renewable potential, economies of scale or more generally the differences across countries in the idiosyncratic inclination to invest in renewable energy projects. Additionally, they account for technological progress and the momentum gained through installed capacities (Polzin et al., 2015a, Marques & Fuinhas, 2012).

Moreover, it is necessary to include several drivers of renewable energy generating capacity in the model, which have been identified by the literature. These concern mainly three topics: general macroeconomics (1-2), energy (3-5) and investor behavior (6-8). The control variables included in $CV_{m,j,k}$ are discussed beneath:

(1) Income

The reasoning behind income as control variable is that wealthier countries have more economic resources available to support the deployment of new technologies via various forms of financial incentives. Consequentially, it is likely that that the economic development of a country impacts its ability to promote investments in the renewable energy sector (Romano et al., 2017; Zhao et al.,2013). Therefore, the logarithm of GDP per capita, one of the most important economic indicators, is used as control in the model for the potentially higher renewable energy capacity additions of wealthier countries. Although all countries in the sample belong to the lower and upper middle-income group, it is important to account for the heterogeneity in economic development.

In addition to its direct effect on the availability of financial resources, GDP per Capita is also likely to indirectly effect renewable energy capacity additions via increasing environmental awareness and growing electricity demand (Pfeiffer & Mulder, 2013).

(2) Foreign Direct Investment

Measured through net inflows as percentage of GDP, this variable clusters factors related to knowledge, capital and technology. Theoretically, the thesis contends that the higher the FDI as proportion of GDP, the higher the level of renewables deployment. This is due to spurred technological progress, improved credit access and knowledge diffusion (Del Rio Gonzales, 2009; De Mello, 1999). Therefore, the thesis considers the role of FDI in its regression analysis like other researchers, who focused on emerging and developing economies like Brunnschweiler (2010) and Romano et al. (2017).

Contrary to this positive effect, it is also possible that electricity as highly regulated production factor might be exposed to decreasing prices in a race to the bottom in an effort to attract foreign investment (Pfeiffer & Mulder, 2013).

(3) Energy Need

To account for differences in energy consumption across countries and thus "normalize" the capacity additions and also to account for population growth, the analysis includes total electricity consumed. The variable is constructed by combining the electricity consumption per capita and population data from the World Bank's development indicators. Next to Polzin et al. (2015a), also Romano et al. (2017) include electricity consumption as control variable. They argue that a higher electricity consumption gives rise to the construction of new renewable energy power plants. Moreover, Aguirre and Ibikunle (2014) control for population growth in their study, because it is likely to put more pressure on the energy supply. Uncertainty prevails over the direction of the effect, since growing energy needs could be supplied by either conventional or renewable sources.

(4) Energy Dependence

While advancing the compliance with international climate agreements, renewable energy support policies are also essential in periods of high fossil fuel price volatility, especially for countries strongly dependent on energy imports (Romano et al., 2017). The ratio of net energy imports to total energy consumption is used as a proxy for energy dependence in this study. The expectation is that a higher dependence on foreign suppliers will positively influence the domestic renewable energy deployment. This is a direct consequence of the political wish to gain more energy security and to protect the national economy through self-sufficiency. For investors it could act as a signal for promising markets with a strong commitment to renewable energy and no competing national fossil fuel reserves.

(5) CO_2 Intensity

The effect of CO_2 emissions per GDP on investments in renewable energy is more difficult to predict. CO_2 emission levels have been suggested as a proxy for environmental concerns and therefore as drivers for investment in renewables (Aguirre & Ibuikunle, 2014; Marques et al., 2010). The fight against CO_2 emissions, a declared target of international conventions not only since COP21, should encourage an increase of renewable energy generation. However, it is also possible that higher pollution is the result of greater economic investment, which might decrease the propensity to invest in renewable electricity generation capacity (Zhao et al., 2013).

(6) Credit Market Imperfections

Access to financing is an important prerequisite for the deployment of renewable energy, due to their comparatively higher fixed costs (Brunnschweiler, 2010; Liming, 2009; Waldhier, 2010). The availability of long- term loans needed by renewable energy projects/ firms is positively correlated to the development of the banking system (Demigruc-Kunt & Maksimovic, 1999).

The proxies for financial sector development in previous studies are based mostly based on Beck et al. (2000). Also, Brunnschweiler (2010) draws upon these indicators when choosing his three financial sector measurements, the commercial bank asset share, the private credit share and financial depth.

The first of these measures signifies the importance of commercial banks' asset share in comparison to that of the central bank. The share of household savings managed by commercial financial institutions versus the one of the central bank is higher in open and more highly developed economies. Next to Brunnschweiler (2010), also Pfeiffer and Mulder (2013) use the ratio of deposit money bank assets to central bank assets in their research on renewable energy.

Secondly, Zhao et al. (2015) include domestic credit to the private sector as proportion of GDP in their analysis and confirm that the ability to raise private finance for renewable energy projects tends to depend heavily on the development of national financial markets. This measure does not include loans given out by development banks or governments. The share of lending to the private sector tends to be larger in an unrestricted financial sector (Brunnschweiler, 2010). Already Levine et al. (2010) proved in his research that this measure is a reliable indicator of financial intermediary development.

The third measure tested by Brunnschweiler (2010) is the financial depth, which is the broadest measure of financial intermediation. While giving an indication of the total size of the financial sector, it does not make a difference between commercial and non-commercial banks, other intermediaries or the use of liabilities. For this reason, the measure is not as robust for developing and emerging economies since these are characterized through a more bank- focused development. Furthermore, Cárdenas Rodríguez et al. (2014) attempts to control for credit market imperfections by including the credit depth in his model, but does not find a significant effect.

Based on the insights from previous studies on renewable energy deployment and the impact of financial market development, as well as data availability for the studied countries, this thesis thus focuses solely on the private credit share as control variable. A positive influence of it on the investment decision for renewable energies is expected.

(7) Ease of Doing Business – Contract Enforcement

Apart from the financial market factors, also the ease of doing business in countries possibly influences investment behavior. As highlighted in the literature review, security of investor's cash flows tends to depend on tariff-based incentive mechanisms or private power purchase agreements, which make the enforcement of contracts an extremely important prerequisite. Therefore, this study includes the contract enforcement scores from the World Bank's Ease of Doing Business Index as control variables. The indicator measures the cost and time necessary to resolve a commercial dispute through a local court in the first instance, as well as the quality of judicial processes (World Bank Group, 2017). The expectation is that a higher performance on the contract enforcement indicator, which mirrors legal security, positively influences renewable energy investor behaviour.

(8) Corruption Index

Finally, the analyzed country set is prone to have corruption problems in their public sector. Corruption is known to decrease investor interest, because it prevents the establishment of fair market structures and distorts competition. Thus, the Corruption Perception Index (CPI) is incorporated to control for institutional improvements over time in the countries. Since a higher CPI implies a less corrupt system, a positive coefficient is expected.

5.3 Econometric Research Strategy

Following the approach of Polzin et al. (2015a) this thesis estimates a model with panel corrected standard errors (PCSE) as this is assumed to be the most appropriate identification strategy by most of the previous research on the topic. (see also Marques & Fuinhas, 2012; Aguiree & Ibikunle, 2014; Romano et al., 2017).

Scholars have highlighted the challenge of possibly overlapping spatial and temporal effects when analyzing the impact of public policies on renewable energy investments (Marques et al. 2010; Marques & Fuinhas, 2012; Polzin et al. 2015a). Building on their work, this thesis assumes panel auto-correlation since a trend towards more policies is evident throughout the data and contemporaneous correlations due to the possibility of policy design similarities.

Thus, the econometric analysis follows the path suggested in Marques and Fuinhas's (2012) methodology. After inspecting the nature of the data, tests for the presence of heteroskedasticity, panel auto-correlation and contemporaneous correlation are performed. This is essential, since these concerns need to be addressed to avoid inconsistencies in coefficient estimations and biases in the standard error estimation. Should the results indeed indicate that the standard assumptions about errors do not hold concerning independence and identical distribution, Beck and Katz's (1995) PCSE estimation method is applied as a proven tool to increase the estimator's quality. Lastly, the results are checked for robustness by comparing them with the most commonly used classical panel data Random Effects Estimator (REE) and Fixed Effects Estimator (FEE).

Following the outlined path, this analysis commences with several diagnostic tests about the data's structure. The results influence the decision on the employed estimation technique; see Table 4 for an illustration of the test statistics. Correlation matrices showing that multicolinearity is not an issue with the underlying panel data are included in the appendix Table A2.

First, the Modified Wald statistics confirm group wise heteroskedasticity in the residuals of the fixed effects regression.

Then, the panel data is tested for serial correlation by applying the Wooldridge Test. The null hypothesis of no first- order autocorrelation can be rejected based on the test statistics for some technologies. A serial tendency can be observed due to the increasing number of policies over time for Solar and Multiple RE.

Lastly, to check for the existence of cross section independence, Pesaran's and Frees' Test are performed. The tests statistics do clearly suggest contemporaneous correlation in the data. Overall most test results are in line with expectations confirming that the policy data is heteroskedastic and that contemporaneous correlation and panel autocorrelation exist.

Table 4: Specification Tests for the Econometric Model

Random Effects/Pooled OLS						**Fixed Effects**				
	Wind	Solar	Biomass	Hydro	Multiple RE	Wind	Solar	Biomass	Hydro	Multiple RE
Modified Wald Test	-	-	-	-	-	16213***	30681***	38669***	52213***	5537***
Wooldridge Test	0,09(OLS)	6,97**(OLS)	0,54(OLS)	1,77(OLS)	5,19**(OLS)	-	-	-	-	-
Pesaran's Test	6,32***	17,42***	7,29***	1,96***	-0,94	5,13***	15,08***	6,75***	1,78*	-0,97
Frees' Test	10,91***	4,38***	7,39***	4,73***	5,69	7,45***	3,72***	9,05***	4,00***	5,58***

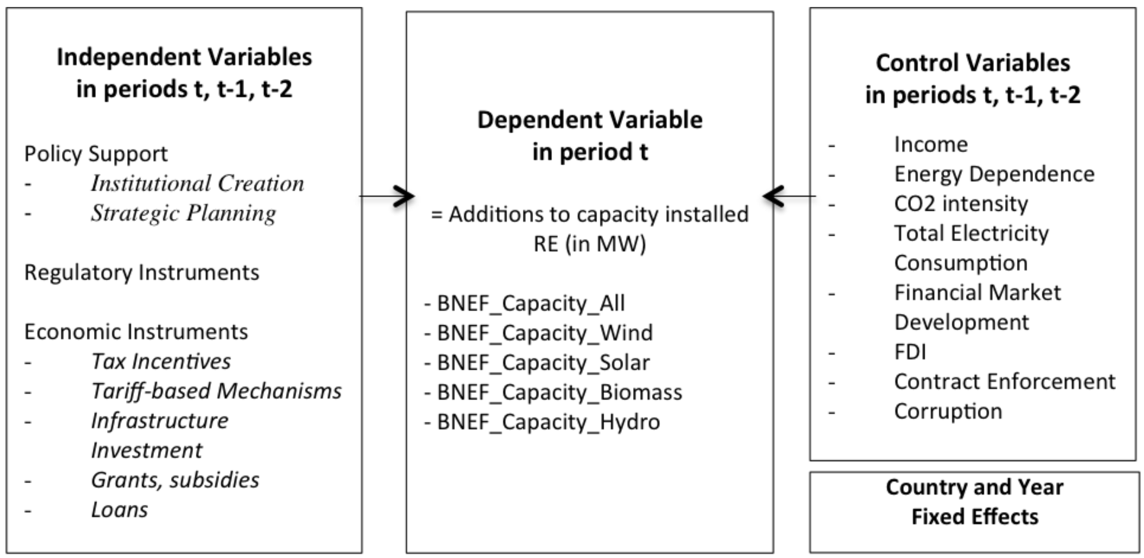
Notes: Woolridge test is N(0,1) and tests the null of no serial correlation. Pesaran's and Frees' test test the null hypothesis of cross-section independence. Pesaran's test is a parametric procedure and follows a standard normal distribution. Frees' test uses Free's Q- distribution; xttest3, xtcsd and xtserial commands were used. (De Hoyos and Sarafidis, 2006)

Thus, the PCSE remains the most suitable estimator to deal with the features of the data and is chosen as main econometric analysis technique. It permits the error term to be correlated over the countries, to be heteroskedastic and additionally time series correlation within the explanatory variable is possible (Cameron & Trivedi, 2010; Polzin et al., 2015a).

The FGLS estimator, also robust to heteroskedasticity and serial correlation, is not an alternative estimation possibility (Marques & Fuinhas, 2012). The requirement for its implementation $T \geq N$, which means that the panel includes more or at least an equal number of time periods as the number of cross sections, is not fulfilled for the underlying dataset (Reed, 2011). The number of countries (46) actually outnumbers the number of time periods (15).

To handle the skewed distribution the logarithm is taken of the dependent, as well as independent variables. Finally, the model encompasses a lag structure of one and two years because policies might not necessarily have an immediate effect on investor behavior, but actually take a few years to induce the investment exhibited through capacity additions. The results are reported in the following section.

Figure 6: Model for Panel Regression



Source: Author

5.4 Robustness Checks and Discussion of Method

To verify the stability of the results the following robustness checks were carried out. First, the usual panel data estimators of Random Effects and Fixed Effects for the model are estimated and compared to the results achieved with the PCSE estimator. Time dummies are used in the REE as well as in the FEE estimations. The regression tables are reported in the appendix (Table A5). All regressions display consistent results, in terms of explanatory effects (negative or positive) of the regressors on investments in renewable energy, the alternative specification generates similar results.

Since BRICS countries feature particularly high growth rates, it is possible that the results are maybe driven primarily by developments in these large emerging economies. Consequentially, it is advisable to check whether excluding these countries alters the main results or reinforces them. Therefore,the second robustness test is conducted through excluding South Africa and Brazil from the analysis (Appendix Table A4), China and India were never included in the sample due to monthly data download restrictions on BNEF. Most coefficients only exhibit slight changes in magnitude, while loans turn significant and regulatory instruments insignificant in the Multiple RE regression. Worthwhile to point out is the magnitude change of the coefficient for tariff-based policy mechanisms in the solar sector, which drops more than half. A possible explanation could be that the Renewable Energy Independent Power Producer Programme (REIPPP) launched by the South African government in 2011, which was particularly successful in the solar industry, influenced the prior magnitude of the result strongly (Kane & Shiao, 2013). However, the overall previous findings can be confirmed.

Although the measurement of the policy variable is an improvement to previous research, limitations relating to the explanatory variable remain.

One possible weakness is that it does not account for the policies' intensity, but only whether a specific policy is in place. Distinct economic, institutional and social environments could cause countries to implement renewable energy policies with varying intensities. However, the size and time frame of the panel make it extremely complicated to improve on this due to very scarce accurate data available. Including fixed effects to control for unobserved time and country heterogeneity helps to mitigate biases possibly caused by not accounting for policy intensity in the estimation.

Moreover, the absence of some policy variables for many countries could be problematic for the econometric treatment. Since a multitude of countries has not yet implemented specific policies or does so only on a minimal scale rather sporadically, an excess amount of zeros in the data is the consequence.

While the analysis controls for factors relevant to investor behaviour such as financial market development, contract enforcement and corruption, it does not include variables on alternative investments. Functioning as substitutes these could influence the attractiveness of renewable energy projects. Unfortunately, the lack of data availability for relevant indicators, like long term interest rates or share prices, on the analyzed country sample did not permit to include these controls.

Lastly the measurement of the dependent variable in absolute terms does not allow conclusions concerning the effectiveness of public policies on altering the overall energy mix of a country towards a higher renewable energy share. Yet, the thesis aims to investigate solely whether the policies foster investment in renewables. Thus, the measurement in capacity additions in MW is appropriate even though it limits interpretation depth.

6 Results and Discussion

This section presents the econometric results, points out significant effective and ineffective policy measures of inducing renewable energy finance and discusses these with respect to findings from previous researchers in this literature field (Romano et al. 2017; Polzin et al. 2015a; Aguirre & Ibikunle, 2014; Pfeiffer & Mulder, 2013; Marques & Fuinhas 2012; Popp et al. 2011; Brunnschweiler, 2010; Johnstone et al. 2010).

The results of the analysis with the PCSE estimator can be found for each technology, as well as the aggregate multiple renewable energy category, in Table 5 below. Displayed are the coefficients of the one period time lag model, which lags the investments and control variables one year behind the policy variable, due to two reasons. On the one hand, it seems more appropriate in mirroring the actual renewable energy deployment process as it accounts for the temporal delay between changing policy landscapes and their transmission into investors' decisions. On the other hand, it allows dismissing the consideration of reverse causality, since investments could possibly drive the introduction of policies as well through lobbying. The regression tables for the PCSE estimation without and a two year time lag can be found in the appendix (Table A1 and A2).

For the included range of control variables in the model there are relatively few instances of statistical significance. Nevertheless, the significantly positive coefficients of the financial market development measure across sectors stand out. This result supports previous literature on the topic (Brunnschweiler, 2010) and highlights the importance of financing constraints in local markets as obstacles to renewable energy investment in developing and emerging countries.

Consistent with previous studies mixed results must be reported for the independent policy variables. Initial results imply that some of the policy measures have no significant effect, and reveal limited explanatory power concerning investments in renewable energy. While numerous other policies have a significant effect on the promotion of renewables investments, the signs are discordant, and in some cases, unexpected.

The analysis is performed on a technology sectoral basis. Hence, it is possible to distinguish policy recommendations. In the aggregate renewables regression many policy variables are not significant and thus do not indicate a clear impact on the promotion of renewable energy investments. The clustering of significant results in the single technology regressions, calls for technology specific policies.

Moreover, the study's results suggest that public polices are not relevant factors in explaining investment decisions in the hydroelectricity sector. The analysis shows no significant result for this technology. This could possibly be due to the fact that even though only small scale hydro projects (<50MW) were included in the research, this technology is already much more mature in comparison to other renewables and therefore investment considerations differ.

Table 5: Panel Corrected Standard Error Estimator Regression - 1 year lag

VARIABLES	Multiple log_BNEF_Capacity	SOLAR log_BNEF_Capacity	WIND log_BNEF_Capacity	HYDRO log_BNEF_Capacity	BIOENERGY log_BNEF_Capacity
Direct Inv. Infrastructure,	-0.059	0.360**	2.869***	0.684	0.572
	(0.426)	(0.149)	(0.820)	(0.440)	(0.642)
Tariff-based Mechanism,	0.344	1.283***	1.528***	-0.061	0.250
	(0.292)	(0.084)	(0.238)	(0.279)	(0.270)
Grants&Subsidies,	-0.403	-0.372*	-1.867**	0.586	-0.984
	(0.535)	(0.191)	(0.935)	(0.969)	(1.008)
Loans,	0.579	0.525***	3.924***	-0.181	0.337
	(0.597)	(0.128)	(1.131)	(0.760)	(0.541)
Tax Incentives,	0.395	-0.842***	-1.274***	0.121	-1.011**
	(0.384)	(0.118)	(0.290)	(0.528)	(0.465)
Institutional Creation,	-0.097	2.353***	3.602***	-0.367	-0.258
	(0.316)	(0.274)	(1.284)	(1.066)	(0.907)
Strategic Planning,	0.450*	-0.426***	-0.756*	-0.212	0.829***
	(0.262)	(0.117)	(0.419)	(0.361)	(0.250)
Regulatory Instruments,	0.698**	0.748***	2.385***	0.324	0.870
	(0.325)	(0.082)	(0.523)	(0.398)	(0.765)
Income,	0.872	-0.994***	0.266	0.750	-0.494
	(0.589)	(0.129)	(0.198)	(0.536)	(0.480)
Contract Enforcement,	-0.049	0.022***	-0.030	0.020	0.022
	(0.031)	(0.004)	(0.020)	(0.019)	(0.016)
Corruption,	0.157	-0.027	-0.079	-0.139	0.260***
	(0.152)	(0.023)	(0.069)	(0.114)	(0.096)
FDI,	-0.005	0.009***	-0.002	-0.007	0.005
	(0.013)	(0.003)	(0.008)	(0.013)	(0.008)
Energy Dependence,	0.001	0.000	0.004*	-0.001	-0.001
	(0.004)	(0.000)	(0.002)	(0.004)	(0.003)
Fin. Market Development,	0.011***	0.004**	0.000	0.006**	0.005*
	(0.003)	(0.001)	(0.002)	(0.003)	(0.003)
Total Electricity Consumption,	-0.170	0.000	0.189	-0.334	0.085
	(0.435)	(0.086)	(0.229)	(0.254)	(0.184)
CO_2 Intensity,	0.482	-1.112***	0.559	1.703**	-0.308
	(1.306)	(0.275)	(0.605)	(0.837)	(0.618)
Observations	561	561	561	561	561
R^2	0.620	0.427	0.509	0.602	0.580
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Net Energy Import and Electricity Consumption data is missing for Belize, Malawi, Rwanda, Sierra Leone and Uganda.

6.1 Economic Instruments

When taking a closer look at the influence of economic instruments on subsequent renewable energy capacity investments, the regression results show interesting characteristics.

Above all, this study provides evidence on the effectiveness of tariff- based support mechanisms as strong signals for renewable energy investors. This is not unexpected since they are the most praised and widely chosen instruments to encourage renewable electricity capacity additions (Menanteau et al., 2003). While Aguirre & Ibikunle (2014) and Popp et al. (2011) were not able to show a statistically significant effect for FiTs, the finding is supported by multiple other researchers. The results align with those from Polzin et. al (2015a), Cardenas Rodriguez et al. (2014), Zhao et al. (2013), and Ragwitz et al. (2007), which reinforces the robustness of the analysis.

Although Romano et al. (2017) find a negative sign for both developing and developed countries, they explain the at first sight contrary finding with the time frame of their study (2004-2011). They argue that FiTs still have to exhibit their effects in developing countries, while they already reached saturation in developed countries. Thus, this study's results covering the years up to 2014 correspond well with Romano et al. (2017) and demonstrate the central role tariff-based mechanisms play in fostering renewables investments.

Moreover, loans and loan guarantees do enhance investment in the solar and especially wind sector. This result is in line with prior research, which demonstrated that loans as well as loan guarantees improved the investors' ability to refinance through lowering the cost of capital (Bergek et al., 2013; De Jager, 2011). The higher magnitude of the wind coefficient could potentially be explained by the on average higher project costs of the more large scale wind parks in comparison to solar, which could cause the wind sector to benefit more from loan programs.

However, grants and subsidies show a negative relationship with investments in the solar and wind sector. The finding is surprising, because the measure is primarily supposed to enhance the financial attractiveness of renewable undertakings, although consistent with some of the current research (Romano et al. 2017). Just as pointed out in the literature review before, investors may have limited confidence in policy instruments, which directly depend on public budgets (Johnstone et al., 2010). This explanation offered by previous literature might apply even more strongly to the underlying set of countries of this study. Additionally grants and subsidies only temporally affect the project finance costs.

Also the negative coefficients for tax related incentives in the solar, wind and bioenergy sector confirm previous findings concerning the reliance on public budgets (Polzin et al.,2015a).

Finally, the economic instruments results highlight effectiveness of direct investments in infrastructure with highly significant positive coefficients for wind and solar sectors. This is in line with prior research, which found that grid expansion was beneficial to investment in and deployment of renewable energy (Steinbach, 2013). Thus, it is recommendable for countries lacking an extensive and modern grid to focus first on infrastructure improvements.

6.2 Policy Support

The results suggest that institutional creation spurs investment in renewable energies. This is reflected by the high level of significance and strong positive relationship between policy support in the form of institutional creation and the dependent variable for the solar and wind sector. The finding is not surprising since existing literature showed already similar results for the aggregate policy support measure (Marques & Fuinhas, 2012).

Strategic planning is only significantly positively linked to bioenergy investments and the aggregate renewable energies category in this study, even negatively to solar and wind. Explanations for this mixed evidence can be found in the literature. On the one hand, the positive coefficients show that clear long-term strategic planning on the side of the government is important to induce investment since investors like to base their decisions on a reliable framework for the future. This corresponds to the need for a strategy to integrate renewables into the prevailing energy system and policy commitment, which has been proven by multiple scholars (Marques & Fuinhas 2012). On the other hand, these scholars mostly focused on EU and OECD countries. Pfeiffer and Mulder (2013) in contrast only included developing countries in their research and found that attention to institutional creation and strategic planning each had a negative impact on renewable energy technology diffusion. This could be due to weak institutions, low levels of human capital, patronage-based processes and a lack of strong democratic control mechanisms. As the negative coefficients for some technology sectors in this thesis hint in a similar direction, governments in developing and emerging markets are probably well advised to bring particular attention to their institutional capacity when formulating renewable energy strategies and setting up new agencies.

6.3 Regulatory Instruments

The significant positive coefficient for regulatory instruments in the wind, solar and aggregate renewable energies sector, underlines the importance of the institutionalization of markets. Codes and standards, mandatory requirements, dispatch or grid access regulations give certainty to market participants and attract investors. Therefore, the thesis confirms Pfeiffer and Mulder (2013), who emphasize the significance of regulatory measures for the growth of renewables in developing countries. The results deliver empirical support for the central role of regulatory instruments in the set up of any effective policy mix.

7 Conclusion

The adoption of the Paris Climate Agreement in 2015 signaled the commitment of international policy makers to keep global warming below 2°C to the private sector. Nevertheless, the forecasted electricity demand growth prospects in many non-OECD countries to accommodate economic growth and to provide universal energy access endanger this goal. An increase in the renewable energy uptake has been widely discussed as solution in the literature. Especially in developing and emerging countries though the lack of financing has been identified as obstacle in the renewable energy project development process.

Yet, despite this evidence, there is a surprising lack of empirical papers in the energy literature examining public policies' impact on investor behaviour in the renewable energy sector of these countries. The thesis represents one of the first attempts to fill in this literature gap. The study focuses on a panel of 46 developing and emerging countries, covering the time span 2000-2014 and applies a panel corrected standard error estimator. The analysis is based on a novel combination of datasets of BNEF asset finance data and policy data encoded by the author. Thus, it makes a contribution to the energy finance and policy literature alike by focusing its analysis on a so far more qualitatively examined country set.

The results indicate that the impact of policies on investment varies by type of policy and energy technology. The study reports mixed evidence on the solar, wind and biomass sector. For investments in hydroelectric plants it does not find significant results possibly due to the technologies maturity. Moreover, it gives empirical support to technology specific policy measures, as they are able to consider particular market conditions and customize the policy according to the technology life cycle.

Investor's decisions for projects are motivated by their risk-return profiles (Dinica, 2006). Economic instruments can directly influence these. Investors highly value the predictable revenue stream of tariff-based support mechanisms. Feed-in Tariffs and auctions, just as loans and loan guarantees, are tackling financing constraints and are supporting private actor's openness towards renewable energy investments. Nevertheless, some economic instruments are found to counter investment rather than promoting it. Grants and tax incentives do not provide the same long-term signals and are possibly viewed as too reliant on public budgets. Concerning policy support measures the findings are ambivalent. While institutional creation is linked only positive, strategic planning does not always encourage investments in renewables potentially caused by the lack of institutional capacity in the examined countries. According to the results, regulatory instruments are just as important for investors. They are especially conducive to investment through reducing the regulatory risk related to market access in historically strongly regulated electricity sectors of developing and emerging countries.

In conclusion, the empirical investigation entails key policy implications which can be summarized as follows. Policy makers should focus on tariff-based support and access to cheaper capital through low interest loans and loan guarantees, build up institutional capacity to enhance their strategic planning and to signal long term commitment and lastly install a transparent strong regulatory framework. Additionally, the results suggest that working on the development of the local financial market will have a positive effect on renewable energy project developments.

Multiple avenues for further research based on this thesis exist. While this study is based on renewable investments of a minimum of 1MW, future studies could analyze the effect of policy measures including also smaller installations or set the focus specifically on off-grid projects. Also the lack of effectiveness of some categories of policies invites further research on overlapping or even conflicting effects of coexisting policies. Furthermore, it could be interesting to investigate whether different types of investors are influenced differently by renewable energy support measures. Finally, a comparison of developing countries grouped by geographic region might bring new insights.

Appendices

Table A1: Country Selection

Countries included				**Countries dropped**
Africa	Asia	Latin America	Middle East	
Botswana, Cameroon, Coted'Ivoire, Ethiopia, Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Tanzania, Uganda, Zambia, Zimbabwe	Bangladesh, Indonesia, Myanmar, Nepal, Pakistan, Sri Lanka, Tajikistan, Vietnam	Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, Venezuela	Egypt, Jordan	Congo (Dem.Rep.), Liberia, Dominican Republic, Lebanon

Pairwise Correlation Coefficients

Table A2: Correlation Matrices

Multiple RE (aggregated sectors)

Variables	EI_DI_Infra	EI_Tarif_Based	EI_Grants_Subsidies	EI_Loans	EI_FI_TR	PS_Institutional	PS_Strategic	RI_aggregate
EI_DI_Infra	1.00							
EI_Tarif_Based	0.29	1.00						
EI_Grants_Subsidies	0.34	0.23	1.00					
EI_Loans	0.26	0.08	0.54	1.00				
EI_FI_TR	0.14	0.13	0.32	0.07	1.00			
PS_Institutional	0.11	0.03	0.19	0.27	0.11	1.00		
PS_Strategic	0.45	0.33	0.38	0.21	0.37	0.29	1.00	
RI_aggregate	0.18	0.12	0.31	0.00	0.53	0.22	0.26	1.00

Wind

Variables	EI_DI_Infra	EI_Tarif_Based	EI_Grants_Subsidies	EI_Loans	EI_FI_TR	PS_Institutional	PS_Strategic	RI_aggregate
EI_DI_Infra	1.00							
EI_Tarif_Based	0.28	1.00						
EI_Grants_Subsidies	0.46	0.49	1.00					
EI_Loans	-0.03	0.28	0.44	1.00				
EI_FI_TR	0.24	0.25	0.08	-0.01	1.00			
PS_Institutional	0.31	0.24	0.47	0.29	0.08	1.00		
PS_Strategic	0.44	0.37	0.36	0.07	0.15	0.45	1.00	
RI_aggregate	-0.04	0.28	0.48	0.38	-0.03	0.26	0.39	1.00

Solar

Variables	EI_DI_Infra	EI_Tarif_Based	EI_Grants_Subsidies	EI_Loans	EI_FI_TR	PS_Institutional	PS_Strategic	RI_aggregate
EI_DI_Infra	1.00							
EI_Tarif_Based	0.13	1.00						
EI_Grants_Subsidies	-0.04	0.45	1.00					
EI_Loans	-0.03	0.34	0.30	1.00				
EI_FI_TR	0.12	0.49	0.34	0.26	1.00			
PS_Institutional	0.19	0.27	0.55	0.33	0.18	1.00		
PS_Strategic	0.56	0.25	0.17	0.01	0.17	0.41	1.00	
RI_aggregate	0.13	0.21	0.33	0.04	0.14	0.28	0.34	1.00

Bioenergy

Variables	EI_DI_Infra	EI_Tarif_Based	EI_Grants_Subsidies	EI_Loans	EI_FI_TR	PS_Institutional	PS_Strategic	RI_aggregate
EI_DI_Infra	1.00							
EI_Tarif_Based	0.29	1.00						
EI_Grants_Subsidies	0.39	0.49	1.00					
EI_Loans	0.25	0.27	0.67	1.00				
EI_FI_TR	0.53	0.44	0.48	0.18	1.00			
PS_Institutional	0.54	0.28	0.46	0.25	0.41	1.00		
PS_Strategic	0.05	0.32	0.24	0.08	0.23	0.08	1.00	
RI_aggregate	0.23	0.33	0.73	0.67	0.18	0.11	0.24	1.00

Hydro

Variables	EI_DI_Infra	EI_Tarif_Based	EI_Grants_Subsidies	EI_Loans	EI_FI_TR	PS_Institutional	PS_Strategic	RI_aggregate
EI_DI_Infra	1.00							
EI_Tarif_Based	0.26	1.00						
EI_Grants_Subsidies	0.36	0.41	1.00					
EI_Loans	0.20	0.32	0.68	1.00				
EI_FI_TR	0.36	0.54	0.34	0.26	1.00			
PS_Institutional	0.21	0.28	0.53	0.25	0.27	1.00		
PS_Strategic	0.12	0.25	0.24	0.19	0.19	0.39	1.00	
RI_aggregate	0.18	0.20	0.40	0.38	0.23	0.39	0.29	1.00

PCSE with other lag structures

Table A3: PCSE Estimator Regression - no time lag

VARIABLES	(1) Multiple log_BNEF_Capacity	(2) SOLAR log_BNEF_Capacity	(3) WIND log_BNEF_Capacity	(4) HYDRO log_BNEF_Capacity	(5) BIOENERGY log_BNEF_Capacity
log_EI_DI_Infra_	-0.634	0.151*	2.340***	0.509	-0.276
	(0.443)	(0.088)	(0.716)	(0.469)	(0.504)
log_EI_Tarif_Based_	0.125	0.430***	1.568***	-0.011	0.501*
	(0.296)	(0.095)	(0.232)	(0.344)	(0.272)
log_EI_Grants_Subsidies_	-0.872	0.202*	-2.254***	1.300	-1.102
	(0.608)	(0.117)	(0.756)	(1.176)	(0.862)
log_EI_Loans_	1.518**	-0.421***	5.328***	0.082	0.396
	(0.631)	(0.072)	(1.201)	(0.792)	(0.535)
log_EI_FI_TR_	0.198	-0.383***	-0.853**	-0.544	0.256
	(0.359)	(0.071)	(0.342)	(0.496)	(0.427)
log_PS_Institutional_	-0.320	1.740***	5.826***	-1.024	0.230
	(0.299)	(0.182)	(0.775)	(1.153)	(0.772)
log_PS_Strategic_	0.505**	0.135**	-0.975**	-0.199	0.838***
	(0.252)	(0.069)	(0.418)	(0.370)	(0.297)
log_RI_aggregate_	0.653*	0.247***	1.594***	0.784*	1.167*
	(0.334)	(0.046)	(0.499)	(0.425)	(0.695)
log_GDP	1.126**	-0.351***	0.354*	1.277**	-0.565
	(0.542)	(0.063)	(0.204)	(0.501)	(0.411)
Contract Enforcement	-0.044	0.002	-0.017	0.007	-0.007
	(0.029)	(0.004)	(0.022)	(0.019)	(0.014)
CPI	-0.056	-0.075***	-0.200***	-0.322***	0.096
	(0.158)	(0.021)	(0.070)	(0.107)	(0.092)
FDI	0.010	0.008***	-0.001	0.004	0.008
	(0.014)	(0.002)	(0.008)	(0.014)	(0.008)
Energy Net Imports	0.004	0.001	0.005**	0.006	-0.004
	(0.004)	(0.000)	(0.002)	(0.005)	(0.003)
Domestic Credit	0.011***	0.005***	0.003	0.008**	0.005*
	(0.004)	(0.001)	(0.002)	(0.003)	(0.003)
log_E.Cons.	0.089	-0.128**	0.239	-0.107	0.057
	(0.379)	(0.055)	(0.237)	(0.290)	(0.160)
CO_2 Intensity	0.894	-0.567**	0.508	1.818**	-0.200
	(1.384)	(0.221)	(0.556)	(0.885)	(0.615)
Observations	561	561	561	561	561
R^2	0.607	0.358	0.540	0.602	0.576
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A4: PCSE Estimator Regression - 2 year lag

VARIABLES	(1) Multiple log_BNEF_Capacity	(2) SOLAR log_BNEF_Capacity	(3) WIND log_BNEF_Capacity	(4) HYDRO log_BNEF_Capacity	(5) BIOENERGY log_BNEF_Capacity
log_EI_DI_Infra_ = L,	0.311	0.334**	1.285	1.089*	-0.422
	(0.430)	(0.140)	(1.001)	(0.643)	(0.700)
log_EI_Tarif_Based_ = L,	0.508	1.445***	1.769***	0.329	0.007
	(0.337)	(0.134)	(0.251)	(0.298)	(0.340)
log_EI_Grants_Subsidies_ = L,	0.447	-0.745*	-1.656*	0.461	-2.360**
	(0.602)	(0.437)	(0.986)	(0.910)	(1.134)
log_EI_Loans_ = L,	-0.526	1.764***	1.879	-0.852	0.699
	(0.755)	(0.180)	(1.346)	(1.031)	(0.765)
log_EI_FI_TR_ = L,	0.138	-0.798***	-1.292***	-0.334	-0.342
	(0.390)	(0.143)	(0.299)	(0.518)	(0.542)
log_PS_Institutional_ = L,	0.035	2.617***	2.457	-0.764	1.453*
	(0.332)	(0.465)	(1.616)	(1.040)	(0.808)
log_PS_Strategic_ = L,	0.705***	-0.741***	-0.774	-0.441	0.709***
	(0.261)	(0.172)	(0.529)	(0.359)	(0.254)
log_RI_aggregate_ = L,	0.827**	1.019***	2.237***	0.360	0.743
	(0.334)	(0.131)	(0.575)	(0.513)	(0.828)
log_GDP = L,	0.332	-0.973***	0.079	-0.213	0.020
	(0.565)	(0.160)	(0.346)	(0.564)	(0.505)
Contract Enforcement = L,	-0.060*	0.025***	-0.014	0.001	0.032
	(0.032)	(0.007)	(0.023)	(0.024)	(0.021)
CPI = L,	0.134	-0.131***	-0.039	0.036	0.209**
	(0.137)	(0.033)	(0.067)	(0.121)	(0.098)
FDI = L,	0.005	0.001	-0.007	0.019	-0.000
	(0.014)	(0.005)	(0.008)	(0.014)	(0.008)
Energy Net Imports = L,	0.008*	0.002**	0.006**	0.001	0.003
	(0.004)	(0.001)	(0.003)	(0.004)	(0.003)
Domestic Credit = L,	0.007*	0.003	0.002	0.005*	0.004
	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)
log_E.Cons. = L,	-0.224	-0.287**	-0.275	0.134	-0.018
	(0.483)	(0.121)	(0.288)	(0.267)	(0.244)
CO_2 Intensity = L,	0.165	-0.322	1.082*	-0.151	-0.241
	(1.171)	(0.299)	(0.650)	(0.867)	(0.728)
Observations	561	561	561	561	561
R^2	0.618	0.456	0.487	0.607	0.570
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Robustness Checks

Table A5: PCSE excl. South Africa and Brazil - 1 year lag

	(1)	(2)	(3)	(4)	(5)
	Multiple	SOLAR	WIND	HYDRO	BIOENERGY
VARIABLES	log_BNEF_Capacity	log_BNEF_Capacity	log_BNEF_Capacity	log_BNEF_Capacity	log_BNEF_Capacity
log_EI_DI_Infra_ = L,	-0.106	0.592***	2.546***	0.701	0.407
	(0.483)	(0.143)	(0.746)	(0.458)	(0.699)
log_EI_Tarif_Based_ = L,	0.335	0.499***	1.306***	0.013	0.352
	(0.292)	(0.055)	(0.307)	(0.342)	(0.327)
log_EI_Grants_Subsidies_ = L,	-0.593	-0.256	-1.911**	-0.914	-1.606
	(0.712)	(0.186)	(0.919)	(1.997)	(1.355)
log_EI_Loans_ = L,	1.378*	0.649***	3.481***	-0.631	-0.304
	(0.785)	(0.072)	(1.284)	(0.993)	(0.914)
log_EI_FI_TR_ = L,	0.583	-0.523***	-1.251***	0.212	-0.948**
	(0.415)	(0.112)	(0.262)	(0.645)	(0.472)
log_PS_Institutional_ = L,	-0.167	2.536***	3.341***	0.411	-0.006
	(0.333)	(0.254)	(1.297)	(1.335)	(0.990)
log_PS_Strategic_ = L,	0.490*	-0.499***	-0.364	-0.182	0.914***
	(0.276)	(0.110)	(0.355)	(0.454)	(0.246)
log_RI_aggregate_ = L,	0.403	0.900***	2.071***	-0.073	0.474
	(0.362)	(0.052)	(0.582)	(0.495)	(0.778)
log_GDP = L,	1.172*	-0.563***	0.697***	0.851*	-0.455
	(0.604)	(0.079)	(0.190)	(0.513)	(0.471)
Contract Enforcement = L,	-0.053	-0.001	-0.036**	0.007	0.013
	(0.032)	(0.003)	(0.016)	(0.020)	(0.013)
CPI = L,	0.206	-0.013	-0.011	-0.106	0.283***
	(0.160)	(0.016)	(0.065)	(0.123)	(0.095)
FDI = L,	-0.001	0.012**	-0.006	-0.004	0.007
	(0.014)	(0.005)	(0.008)	(0.014)	(0.008)
Energy Net Imports = L,	0.001	-0.001**	0.004*	-0.001	-0.001
	(0.004)	(0.000)	(0.002)	(0.004)	(0.003)
Domestic Credit = L,	0.008*	-0.000	-0.004*	0.007*	0.005*
	(0.005)	(0.001)	(0.003)	(0.004)	(0.003)
log_E.Cons. = L,	-0.122	0.197***	0.123	-0.388	0.040
	(0.439)	(0.058)	(0.257)	(0.243)	(0.209)
CO2 Intensity = L,	1.308	-0.413***	1.475***	1.876**	-0.243
	(1.347)	(0.133)	(0.571)	(0.863)	(0.642)
Observations	533	533	533	533	533
R^2	0.582	0.396	0.490	0.523	0.420
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6: Fixed and Random Effects Regression - 1 year lag

VARIABLES	(1) FEE Multiple log_BNEF_Capacity	(2) REE Multiple log_BNEF_Capacity	(3) FEE SOLAR log_BNEF_Capacity	(4) REE SOLAR log_BNEF_Capacity	(5) FEE WIND log_BNEF_Capacity	(6) REE WIND log_BNEF_Capacity	(7) FEE HYDRO log_BNEF_Capacity	(8) REE HYDRO log_BNEF_Capacity	(9) FEE BIOENERGY log_BNEF_Capacity	(10) REE BIOENERGY log_BNEF_Capacity
log_EI_DI_Infra_ = L,	-0.059	0.026	0.360	0.231	2.869***	2.277***	0.684	0.350	0.572	0.776
	(0.580)	(0.514)	(0.339)	(0.293)	(1.021)	(0.864)	(0.730)	(0.670)	(0.782)	(0.750)
log_EI_Tarif_Based_ = L,	0.344	0.253	1.283***	0.991***	1.528***	1.345***	-0.061	-0.000	0.250	0.415
	(0.354)	(0.332)	(0.236)	(0.196)	(0.335)	(0.284)	(0.323)	(0.307)	(0.264)	(0.252)
log_EI_Grants_Subsidies_ = L,	-0.403	-0.832	-0.372	-0.472	-1.867**	-1.613***	0.586	0.983	-0.984	-0.645
	(0.608)	(0.555)	(0.471)	(0.425)	(0.757)	(0.573)	(1.018)	(0.968)	(0.798)	(0.777)
log_EI_Loans_ = L,	0.579	0.957	0.525	0.269	3.924***	2.873***	-0.181	-0.196	0.337	0.772
	(0.726)	(0.681)	(0.583)	(0.520)	(0.867)	(0.707)	(0.900)	(0.875)	(0.745)	(0.707)
log_EI_FI_TR_ = L,	0.395	0.374	-0.842***	-0.647***	-1.274***	-0.936***	0.121	0.245	-1.011*	-1.346**
	(0.343)	(0.311)	(0.227)	(0.168)	(0.468)	(0.286)	(0.495)	(0.435)	(0.564)	(0.543)
log_PS_Institutional_ = L,	-0.097	-0.011	2.353***	2.239***	3.602***	3.424***	-0.367	-0.935	-0.258	-0.394
	(0.394)	(0.355)	(0.573)	(0.478)	(0.959)	(0.839)	(1.043)	(0.987)	(0.828)	(0.775)
log_PS_Strategic_ = L,	0.450	0.566**	-0.426*	-0.337	-0.756	-0.487	-0.212	-0.119	0.829**	0.842***
	(0.308)	(0.272)	(0.245)	(0.208)	(0.468)	(0.366)	(0.409)	(0.396)	(0.329)	(0.299)
log_RI_aggregate_ = L,	0.698**	0.713**	0.748***	0.634***	2.385***	2.519***	0.324	0.578	0.870	1.046**
	(0.334)	(0.291)	(0.265)	(0.203)	(0.619)	(0.449)	(0.437)	(0.399)	(0.539)	(0.522)
log_GDP = L,	0.872	0.391	-0.994**	-0.061	0.266	0.070	0.750	0.416**	-0.494	0.126
	(0.902)	(0.261)	(0.425)	(0.064)	(0.783)	(0.116)	(0.696)	(0.209)	(0.622)	(0.142)
Contract Enforcement = L,	-0.049	-0.016	0.022	-0.003	-0.030	-0.004	0.020	-0.001	0.022	0.003
	(0.049)	(0.017)	(0.024)	(0.004)	(0.042)	(0.007)	(0.038)	(0.014)	(0.034)	(0.009)
CPI = L,	0.157	0.084	-0.027	0.062	-0.079	0.006	-0.139	-0.189	0.260**	0.051
	(0.178)	(0.147)	(0.087)	(0.048)	(0.159)	(0.087)	(0.140)	(0.119)	(0.125)	(0.096)
FDI = L,	-0.005	-0.005	0.009	-0.003	-0.002	-0.001	-0.007	-0.002	0.005	-0.001
	(0.023)	(0.021)	(0.011)	(0.010)	(0.020)	(0.017)	(0.019)	(0.018)	(0.016)	(0.015)
Energy Net Imports = L,	0.001	0.002	0.000	0.000	0.004	0.003**	-0.001	-0.001	-0.001	0.002
	(0.005)	(0.003)	(0.002)	(0.001)	(0.004)	(0.001)	(0.004)	(0.002)	(0.003)	(0.002)
Domestic Credit = L,	0.011***	0.011***	0.004*	0.005***	0.000	0.000	0.006**	0.007**	0.005*	0.005**
	(0.004)	(0.004)	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
log_E.Cons. = L,	-0.170	0.450**	0.000	0.031	0.189	0.071	-0.334	0.194	0.085	0.376***
	(0.551)	(0.177)	(0.258)	(0.039)	(0.472)	(0.076)	(0.426)	(0.143)	(0.375)	(0.095)
CO_2 Intensity = L,	0.482	-0.769	-1.112*	0.082	0.559	0.741**	1.703*	-0.347	-0.308	-0.966**
	(1.240)	(0.690)	(0.599)	(0.169)	(1.092)	(0.311)	(0.995)	(0.558)	(0.869)	(0.392)
Observations	561	561	561	561	561	561	561	561	561	561
R^2	0.193		0.345		0.293		0.080		0.097	
Country FE	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

References

Abdmouleh, Z., Alammari, R., & Gastli, A. (2015). Review of Policies Encouraging Renewable Energy Integration & Best Practices. Renewable And Sustainable Energy Reviews, 45, 249-262.

Asif, M., Muneer, T. (2007). Energy Supply, its Demand and Security Issues for Developed and Emerging Economies. Renewable and Sustainable Energy Reviews 11, 1388–1413.

Bacon, R. & Besant-Jones, J. (2001). Global Electric Power Reform, Privatization, and Liberalization of the Electric Power Industry in Developing Countries. Annual Review Of Energy And The Environment, 26(1), 331-359.

Baldwin, L. (2006). Political Risk in Sub-Saharan Africa. Infrastructure Journal Online 41: 35-38.

Barradale, M. (2010). Impact of Public Policy Uncertainty on Renewable Energy Investment: Wind Power and the Production Tax Credit. Energy Policy, 38(12), 7698-7709.

Beck, T., Demirguc-Kunt, A., & Levine, R. (2000). A New Database on the Structure and Development of the Financial Sector. The World Bank Economic Review, 14(3), 597-605.

Beck, N., & Katz, J. (1995). What To Do (and Not to Do) with Time-Series Cross-Section Data. American Political Science Review, 89(03), 634-647.

Becker, B. & Fischer, D. (2013). Promoting Renewable Electricity Generation in Emerging Economies. Energy Policy, 56, 446-455.

Bergek, A., & Jacobsson, S. (2010). Are Tradable Green Certificates a Cost-efficient Policy Driving Technical Change or a Rent-generating Machine? Lessons from Sweden 2003–2008. Energy Policy, 38(3), 1255-1271.

Bergek, A., Mignon, I., & Sundberg, G. (2013). Who Invests in Renewable Electricity Production? Empirical Evidence and Suggestions for Further Research. Energy Policy, 56, 568-581.

Bird, L., Bolinger, M., Gagliano, T., Wiser, R., Brown, M., & Parsons, B. (2005). Policies and Market Factors Driving Wind Power Development in the United States. Energy Policy, 33(11), 1397-1407.

Bleaney, M. (1996). Macroeconomic Stability, Investment and Growth in Developing Countries. Journal Of Development Economics, 48(2), 461-477.

BNEF (2017). Bloomberg New Energy Finance. Bloomberg.

Bridle, R., & Kitson, L. (2014). The Impact of Fossil-Fuel Subsidies on Renewable Electricity Generation (1st ed.). The International Institute for Sustainable Development, Geneva.

Brunnschweiler, C. (2010). Finance for Renewable Energy: an Empirical Analysis of Developing and Transition Economies. Environment And Development Economics, 15(03), 241-274.

Bürer, M.J. & Wüstenhagen, R., (2009). Which Renewable Energy Policy is a Venture Capitalist's Best Friend? Empirical Evidence from a Survey of International Clean Tech Investors. Energy Policy 37 (12), 4997–5006.

Cameron, A., & Trivedi, P. (2010). Microeconometrics Using Stata (1st ed.). College Station, Texas: Stata Press.

Cansino, J., Pablo-Romero, M., Román, R., & Yñiguez, R. (2010). Tax Incentives to Promote Green Electricity: An Overview of EU-27 Countries. Energy Policy, 38(10), 6000-6008.

Cárdenas Rodríguez, M., Hascuc, I., Johnstone, N., Silva & J., Ferey, A. (2014), Inducing Private Finance for Renewable Energy Projects: Evidence from Micro- Data, OECD Environment Working Papers, No. 67, OECD Publishing, Paris.

Chang, Y., Fang, Z., & Li, Y. (2016). Renewable Energy Policies in Promoting Financing and Investment among the East Asia Summit Countries: Quantitative Assessment and Policy Implications. Energy Policy, 95, 427-436.

Climatescope – The Clean Energy Country Competitiveness Index (2016). London.

Couture, T., & Gagnon, Y. (2010). An Analysis of Feed-in tariff Remuneration Models: Implications for Renewable Energy Investment. Energy Policy, 38(2), 955-965.

De Hoyos, R., & Sarafidis, V. (2006). Testing for Cross-sectional Dependence in Panel Data Models. The Stata Journal, 6(4), 482–496.

De Jager, D., & Rathmann, M., (2008). Policy Instrument Design to Reduce Financing Costs in Renewable Energy Technology Projects. Ecofys, Utrecht.

De Jager, D., Klessman, C., Striker, E., Winker, T., et al. (2011). Financing Renewable Energy in European Energy Markets. Ecofys, Utrecht.

De Mello, L. (1999). Foreign Direct Investment-led Growth: Evidence from Time Series and Panel Data. Oxford Economic Papers, 51(1), 133-151.

Del Río González, P. (2009). The Empirical Analysis of the Determinants for Environmental Technological Change: A Research Agenda. Ecological Economics, 68(3), 861-878.

Demirgüç-Kunt, A., & Maksimovic, V. (1999). Institutions, Financial Markets, and Firm Debt Maturity. Journal Of Financial Economics, 54(3), 295-336.

Dinica, V. (2006). Support Systems for the Diffusion of Renewable Energy Technologies—an Investor Perspective. Energy Policy, 34(4), 461-480.

Foxon, T. & Pearson, P. (2008). Overcoming Barriers to Innovation and Diffusion of Cleaner Technologies: Some Features of a Sustainable Innovation Policy Regime. Journal Of Cleaner Production, 16(1), S148-S161.

Frankfurt School-UNEP Centre. (2016). Global Trends in Renewable Energy Investment 2016, Frankfurt am Main.

Friebe, C., von Flotow, P., & Täube, F. (2014). Exploring Technology Diffusion in Emerging Markets – the Role of Public Policy for Wind Energy. Energy Policy, 70, 217-226.

Frondel, M., Ritter, N., & Schmidt, C. (2008). Germany's Solar Cell Promotion: Dark Clouds on the Horizon. Energy Policy, 36(11), 4198-4204.

Gray, W., & Shadbegian, R. (1998). Environmental Regulation, Investment Timing, and Technology Choice. The Journal Of Industrial Economics, 46(2), 235-256.

Hair. J., (2010). Multivariate Data Analysis: A Global Perspective, 7th ed. Pearson Education. Upper Saddle River, NJ, London.

Helm, D. (2002). Energy Policy: Security of Supply, Sustainability and Competition. Energy Policy, 30(3), 173-184.

IEA, 2014. African Energy Outlook. International Energy Agency, Paris.

IEA, 2015. World Energy Outlook. International Energy Agency, Paris.

IEA, 2016. World Energy Outlook. International Energy Agency, Paris.

IPCC, 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva.

IRENA, 2012. Financial Mechanisms and Investment Frameworks for Renewables in Developing Countries. International Renewable Energy Agency, Abu Dhabi.

Jefferson, M. (2008). Accelerating the Transition to Sustainable Energy Systems. Energy Policy, 36(11), 4116-4125.

Jensen, S. & Skytte, K. (2002). Interactions between the Power and Green Certificate Markets. Energy Policy, 30(5), 425-435.

Johnstone, N., Haščič, I., & Popp, D. (2009). Renewable Energy Policies and Technological Innovation: Evidence Based on Patent Counts. Environmental And Resource Economics, 45(1), 133-155.

Kaminker, C. and F. Stewart (2012), The Role of Institutional Investors in Financing Clean Energy, OECD Working Papers on Finance, Insurance and Private Pensions, No. 23, OECD Publishing, Paris.

Kane, B., & Shiao, M. (2013). How Real is the South African PV Market?. GreenTech Media. Retrieved 13 May 2017

Kessides, I. (2012). The Impacts of Electricity Sector Reforms in Developing Countries. The Electricity Journal, 25(6), 79-88.

Komendantova, N., Patt, A., Barras, L., & Battaglini, A. (2012). Perception of Risks in Renewable Energy Projects: The Case of Concentrated Solar Power in North Africa. Energy Policy, 40, 103-109.

Liming, H. (2009). Financing Rural Renewable Energy: A Comparison between China and India. Renewable And Sustainable Energy Reviews, 13(5), 1096-1103.

Lucas, H., Ferroukhi, R. & Hawila, D. (2013). Renewable Energy Auctions in Developing Countries. International Renewable Energy Agency (IRENA).

Lund, H. (2007). Renewable Energy Strategies for Sustainable Development. Energy, 32(6), 912-919.

Lüthi, S. & Prässler, T. (2011). Analyzing Policy Support Instruments and Regulatory Risk Factors for Wind Energy Deployment—A Developers' Perspective. Energy Policy, 39(9), 4876-4892.

Lüthi, S. & Wüstenhagen, R. (2012). The Price of Policy Risk — Empirical Insights from Choice Experiments with European Photovoltaic Project Developers. Energy Economics, 34(4), 1001-1011.

Marques, A. & Fuinhas, J. (2012). Are Public Policies towards Renewables Successful? Evidence from European Countries. Renewable Energy, 44, 109-118.

Marques, A., Fuinhas, J., & Pires Manso, J. (2010). Motivations Driving Renewable Energy in European Countries: A Panel Data Approach. Energy Policy, 38(11), 6877-6885.

Mathews, J., Kidney, S., Mallon, K., & Hughes, M. (2010). Mobilizing Private Finance to Drive an Energy Industrial Revolution. Energy Policy, 38(7), 3263-3265.

Masini, A., & Menichetti, E. (2013). Investment Decisions in the Renewable Energy Sector: An Analysis of Non-Financial Drivers. Technological Forecasting and Social Change 80(3), 510-524.

Menanteau, P., Finon, D., & Lamy, M. (2003). Prices versus Quantities: Choosing Policies for Promoting the Development of Renewable Energy. Energy Policy, 31(8), 799-812.

Menz, F.C., & Vachon,S. (2006). The Effectiveness of Different Policy Regimes for Promoting Wind Power: Experiences from the States. Energy Policy 34, 1786–1796.

Mercator, 2016. Global Advanced Energy Insights Report. (4th ed.). San Mateo.

Mueller, S., Brown, A. & Olz, S. (2011). Renewable Energy: Policy Considerations for Deploying Renewables. International Energy Agency, Paris.

Mulder, P. & Tembe, J. (2008). Rural Electrification in an Imperfect World: A Case Study from Mozambique. Energy Policy, 36(8), 2785-2794.

Nagayama, H. (2009). Electric Power Sector Reform Liberalization Models and Electric Power Prices in Developing Countries. Energy Economics, 31(3), 463-472.

Nelson, D. & Shrimali, G. (2014). Finance Mechanisms for Lowering the Cost of Renewable Energy in Rapidly Developing Countries (1st ed.). Climate Policy Initiative, San Francisco.

Nelson, D., Pierpont, B. (2013). The Challenge of Institutional Investment in Renewable Energy. Climate Policy Initiative, San Francisco.

Painuly, J. (2001). Barriers to Renewable Energy Penetration; a Framework for Analysis. Renewable Energy, 24(1), 73-89.

Pfeiffer, B., & Mulder, P. (2013). Explaining the Diffusion of Renewable Energy Technology in Developing Countries. Energy Economics, 40, 285-296.

Pollitt, M. (2008). Electricity Reform in Argentina: Lessons for Developing Countries. Energy Economics, 30(4), 1536-1567.

Polzin, F., Migendt, M., Täube, F., & von Flotow, P. (2015a). Public Policy Influence on Renewable Energy Investments—A Panel Data Study across OECD Countries. Energy Policy, 80, 98-111.

Polzin, F., von den Hoff, M., & Jung, M. (2015b) Drivers and Barriers for Renewable Energy Investments in Emerging Countries- The Case of Wind Energy in China, India and Brazil. SSRN Electronic Journal.

Popp, D. (2009). Exploring Links Between Innovation and Diffusion: Adoption of NOX Control Technologies at US Coal-fired Power Plants. Environmental And Resource Economics, 45(3), 319-352.

Popp, D., Hascic, I., & Medhi, N. (2011). Technology and the Diffusion of Renewable Energy. Energy Economics, 33(4), 648-662.

Quirion, P. (2010). Complying with the Kyoto Protocol under Uncertainty: Taxes or Tradable Permits?. Energy Policy, 38(9), 5166-5173.

Ragwitz M, Held A, Resch G, Faber T, Haas R, Huber C, et al. (2007). Assessment and Optimisation of Renewable Energy Support Schemes in the European Electricity market. Fraunhofer IRB Verlag.

Reed, W., & Ye, H. (2011). Which Panel Data Estimator Should I Use?. Applied Economics, 43(8), 985-1000.

REN21 (2016), Renewables 2016 Global Status Report, REN21 Secretariat, Paris. (Lead author Janet Sawin.)

Rogge, K., Schneider, M., & Hoffmann, V. (2011). The Innovation Impact of the EU Emission Trading System — Findings of Company Case Studies in the German Power Sector. Ecological Economics, 70(3), 513-523.

Romano, A., Scandurra, G., Carfora, A., & Fodor, M. (2017). Renewable Investments: The Impact of Green Policies in Developing and Developed Countries. Renewable And Sustainable Energy Reviews, 68, 738-747.

Romano, A., Scandurra, G., & Carfora, A. (2015). Probabilities to Adopt Feed-in Tariffs Conditioned to Economic Transition: A Scenario Analysis. Renewable Energy, 83, 988-997.

SE4All, 2016. Sustainable Energy for All- Strategic Framework for Results 2016-21. Vienna.

Schmidt, T. S. (2014). Low-carbon Investment Risks and De-risking. Nature Climate Change, 4(4), 237–239.

Shen, J., & Luo, C., (2015). Overall Review of Renewable Energy Subsidy Policies in China – Contradictions of Intentions and Effects. Renewable and Sustainable Energy Reviews. 41, 1478–1488.

Smith, S., & Swierzbinski, J., (2007). Assessing the Performance of the UK Emissions Trading Scheme. Environmental And Resource Economics, 37(1), 131-158.

Steinbach, A. (2013). Barriers and Solutions for Expansion of Electricity Grids—the German Experience. Energy Policy, 63, 224-229.

Szabó, S. & Jäger-Waldau, A. (2008). More Competition: Threat or Chance for Financing Renewable Electricity?. Energy Policy, 36(4), 1436-1447.

Tsoutsos, T., & Stamboulis, Y., (2005). The Sustainable Diffusion of Renewable Energy Technologies as an Example of an Innovation-focused Policy. Technovation, 25(7), 753-761.

UNEP, 2012. Financing Renewable Energy In Developing Countries - Drivers And Barriers For Private Finance In Sub-Saharan Africa, UNEP - Finance Initiative, Geneva.

Urban, F., Benders, R., & Moll, H. (2007). Modelling Energy Systems for Developing Countries. Energy Policy, 35(6), 3473-3482. 5

Waldhier, M. (2010). Financing Renewable Energy Projects: An Overview. Penn State University, Working Paper.

Waissbein, O., Glemarec, Y., Bayraktar, H. & Schmidt, T.S. (2013). Derisking Renewable Energy Investment. A Framework to Support Policymakers in Selecting Public Instruments to Promote Renewable Energy Investment in Developing Countries. UNDP, New York.

White, W., Lunnan, A., Nybakk, E., & Kulisic, B. (2013). The Role of Governments in Renewable Energy: The Importance of Policy Consistency. Biomass And Bioenergy, 57, 97-105.

Wiser, R., & Pickle, S. (1998). Financing Investments in Renewable Energy: the Impacts of Policy Design. Renewable And Sustainable Energy Reviews, 2(4), 361-386.

World Bank Group (2017). Enforcing Contracts - Doing Business, Doingbusiness.org. Retrieved 13 May 2017, from http://www.doingbusiness.org/data/exploretopics/enforcing-contracts

Wüstenhagen, R. & Menichetti, E. (2012). Strategic Choices for Renewable Energy Investment: Conceptual Framework and Opportunities for further Research. Energy Policy, 40, 1-10.

Yoo, S. & Lee, J. (2010). Electricity Consumption and Economic Growth: A Cross-country Analysis. Energy Policy, 38(1), 622-625.

Zhao, Y., Tang, K., & Wang, L. (2013). Do Renewable Electricity Policies Promote Renewable Electricity Generation? Evidence from Panel Data. Energy Policy, 62, 887-897.