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Do policies influence FDI in wind energy? Analysis across Indian states

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Paper submitted for the VIII Annual conference of Knowledge Forum to be held at IIT Bombay (during Oct 25-27, 2013)

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1. Introduction

Last few years have witnessed increased reliance on renewable energy (RE) across the world for two reasons: to ensure energy security and to reduce green-house gas (GHG) emissions. Increased deployment of RE sources has been feasible through pro-active policy initiatives. These policy objectives aim to facilitate the diversification of electricity generation mixes, reduce reliance on fossil fuels, help RE sources becoming cost competitive with conventional energy sources, reduce carbon emissions, or various combination of these objectives (Carley, 2009). In a country like India, increasing investment in the deployment of (decentralized) RE technologies not only facilitates reduction in carbon footprints, but it also helps in the provision of much needed energy to people and promotes economic development. According to some, use of RE technologies will be a 'win-win' opportunity for India (see for example, Schmid, 2012 among others). This is because in the next quarter century, India's electricity demand is expected to grow at an annual average rate of 7.4% (World Bank, 2010). Increased reliance on RE, which has low marginal generation cost, on one hand, can facilitate reduced oil and import dependence thereby increase the energy security, on the other, can mitigate adverse effect of climate change[1] (Schmid 2012).

Perhaps that is the reason serious efforts have been made in India to promote RE including allowing 100 per cent foreign direct investment (FDI) in the sector. The data indicates that FDI inflows in RE sector have increased multifold in last seven years (Rs. 7 million in 2004 to over 20 billion in 2011). Sources of RE are many, but among all the sources, wind energy has received maximum investor attention. Of the three major subsectors of RE – wind has received maximum FDI (≈ 80%) followed by Solar (over 5%) and Biomass (≈ 1.7%) (Figure 1). In comparison to the total FDI inflows, though RE sector received miniscule investments, however the total investment in RE has increased substantially. Proactive policy, resource availability and the success of the indigenous wind energy producers and developers like Suzlon could be the plausible factors contributing to preference of wind energy over other RE resources (Table 1).

The data also shows that of the total FDI in RE in last seven years, 86% has gone to only few states falling in five regions – Mumbai (≈ 49%), Hyderabad (≈ 18%), Chennai (≈ 10%), Bangalore (≈ 5%) and Delhi (≈ 4%). For wind, only five states have received most FDI. In decreasing order, these are Gujarat, Maharashtra, Tamil Nadu (TN), Karnataka and Andhra Pradesh (AP) (Figure 2). Besides these five states, three other states – Rajasthan, Madhya Pradesh (MP) and Kerala, which though have framed policies for renewable / wind energy, have hardly attracted any FDI. Are there institutional differences that have led to differential FDI to different states in India? This study is an attempt to investigate this.

[1]It is estimated that every 1 GW (Giga-watt) of additional RE capacity on an average reduces 3.3 million tons of CO_2 annually (World Bank, 2010).

The key policies by different states to attract investment in wind RE are feed-in-tariff, open access transmission, third party sale, banking, and wheeling charges. In order to see the role of institutional differences, a policy index is created. Panel data techniques are then employed to investigate the impact of the policy differences on renewable FDI for the 8 states over the seven year period (2004-05 to 2010-11) after controlling for several state-specific factors. The controlling factors include per-capita income of the state, grid connectivity, per capita power consumption, power deficit, and share of manufacturing in the SDP. The results indicate that state-specific policy index for wind RE is significant in attracting FDI in a state irrespective of whether control variables are included or not. Higher per capita power consumption or per capita income is an indication of better performing states, thereby facilitate FDI apart from the state-policy index. On the other hand, the power-deficit situation in a state does not guarantee that it will attract FDI. Our results for state-specific policy index remain robust even if we introduce state-specific dummy instead of control variables. The study thus demonstrates the important role of policies in influencing RE FDI.

The remaining paper is organized as follows: Next section gives the wind energy potential across various states in India and also different policies pursued to promote wind energy in India. Section 3 summarizes literature on the role of policies in attracting investment. Section 4 gives the methodology to see the impact of policy on FDI in wind energy. Since different states have pursued different policies to attract investment, in Section 5 we build a composite policy index for the policies. Section 6 gives the estimation results and the paper concludes in Section 7.

2. Wind potential in India

The Centre for Wind Energy Technology (C-WET), an autonomous institution established under the aegis of the Ministry of New and Renewable Energy (MNRE) has estimated that Gujarat, Maharashtra, AP and TN are the states with the highest estimated wind potential at 50 meters height. The data shows that of the total 49 GW potential, 93 per cent potential[2] is only in seven states, namely Gujarat, Karnataka, Maharashtra, AP, TN, J&K and Rajasthan (Figure 3). The present study focuses on six of these states except J&K and also includes Kerala and MP for the analysis. These eight states are chosen on the basis of the active policies formulated to attract wind energy during the time period of the study.

2.1 Ownership structure

Renewable energy installed capacity is indicative of state's participation in development of RE resources. Further, the ownership structure of the installed capacity sheds light on participation of the public and private sector in developing these RE resources. All of the states have shown increase in the installed capacity of RE resources from 2007 to 2010.In TN, RE resources is approximately half the share of the total energy installed capacity. The ownership of installed capacity is classified into two categories namely, public and private ownership. While in most of the sampled states, approximately 14% of the total energy

[2]The share of these states remains over 91 per cent (of total 102 GW) even if installable height of 80 meter is considered instead of 50 meter.

installed capacity is privately owned with Kerala being an exception having no private participation as on 2010 (Figure 4). The All India average of installed capacity in renewable resource to the total energy installed is about 10 %.

2.2 Renewable energy policy in India

The initiative to encourage development of RE resources in India has a history dating to almost three decades. An independent Ministry dedicated to development of renewable resources was setup in 1992 as the Ministry of Non-Conventional Energy Sources, which was renamed as Ministry of New and Renewable Energy (MNRE) in the year 2006. The Ministry is the nodal agency in designing and implementing regulatory framework for the development of RE resources. Apart from the regulations from MNRE, as RE is a constituent of power generated, a regulation by the Power Ministry is also applicable to RE development. To give impetus to RE, the sector was first classified as an independent industrial sector in November 2004.

The focus on grid connected RE was emphasized in the Electricity Act (EA), 2003. Following EA 2003, RE generation, transmission, distribution, trading and use of energy is regulated by Central and State Electricity Regulatory Commissions. In concordance with the EA 2003, National Electricity Policy 2005 was framed and is key in providing guidelines to the functioning of Electricity Regulatory Commission in designing policy framework. Subsequently, Tariff Policy, 2006 was framed which focused on ensuring electricity and competitive price, financial viability of the projects, attracting investment into the project, minimizing of regulatory hassles, promotion of completion and improve the quality of the power supply.

Regarding FDI, two key policies were announced by MNRE in December 2009, which would have affected flow of FDI directly and indirectly. On 14th December 2009, 100% FDI in RE sector was allowed. This policy announcement is in symbiosis with the RBI's Automatic Route for FDI inflows. The route does not require the investor to seek prior permission from the government of India (GoI) or RBI. It only requires notification of share of investment to the concerned regional office of RBI within thirty days of inward remittance and is the main channel through with FDI inflows is routed. Another key policy announced in December 2009 is the generation based incentive (GBI). Both these policies seem to have contributed to increased FDI in 2010 and 2011. Of the total Rs. 27383 mn FDI received in wind, 58% has come in 2010 and 2011 only. Figure 5 gives the timeline of different central level policies / Acts to promote wind energy.

Energy being listed in the Concurrent List, though the Centre and the States formulated policies, the State policies is given an upper hand over the Central policies. However the States polices are expected to align with the Central policies. In section 4, we discuss about the state enacted policies.

3. Review of literature

This section reviews the studies carried out to see the effect of policies on promoting RE. In the Indian context, there are only a handful of studies that have attempted to see the role of government policies on RE development (see for example, Schmidt, 2011; Rao and Prasad, 2010).

Schmid (2011) focus on the effectiveness of two national level policies - The Electricity Act of 2003 and the Tariff Policy of 2006 - in growth of grid connected RE resources. The study finds that both the policies have contributed to increased grid connected RE significantly. The studyalso underlines the importance of the state level policy in boosting grid connected RE. Further the paper suggests that incentive like repurchase obligation has positively contributed to growth in grid connected RE resources while measures such as feed in tariff (FiT) is rendered ineffective. An interesting result of the study is that policies ensuring demand for RE are more effective than capital incentives.

Benecke (2008), in his study of two States in India- TN and Kerala, reports the nature of the Government policies and power position in the States has determined the current RE position in these States. Kerala enjoys energy security and therefore has less incentive to promote RE technology.[3] The legislations in the State are slow and tedious and the policies are sticky in nature. Moreover the establishment of ANERT (Agency for Non-Conventional Energy and Rural Technology) as the State nodal agency of the MNRE is inefficient with regard to the lack of expertise, changing staff and lack of vision (*ibid*.). In contrast, more progressive state, TN, was receptive to MNRE polices since the inception of the Sate nodal agency. Further a vast coastline ensures excellent resource availability (wind conditions) besides collaboration of generators with international wind energy technology suppliers and keenness to have private participation in wind energy development (*ibid*.).

Jagadeesh (1999) also adopts a case study method to pin down factors that has contributed to sudden boon and a subsequent fall in wind energy development in TN and AP till mid-1990s. The study suggests that factors such as capital incentives, technical assistance, infrastructure, growth in textile and cement industry and effective execution of wind energy projects are the reasons for the boom in wind energy production. While a decline in capital assistance or incentives, unsound technical assistance along with import of unsuitable turbines, unwarranted expansion of wind mills and the economic slowdown in cement and textile industry as the basis of for the recession in wind energy generation in these two states (*ibid*.).

Rajeshekar *et al.* (1998) focus on the wind energy programs initiatives in India. The effectiveness of various initiatives is identified to benefit varied business motives variedly. The study bifurcates wind energy producers as tax-credit seekers, power seekers and manufactures. The tax-credit seeker companies are those where the company decision are governed by the tax liabilities incurred. Power seeker companies are set-up based on the additional energy requirement for each state and manufactures are those who manufacture wind turbines. The authors find that capital incentives provide a plus factor in wind energy generation and development especially in the initial phase. However for a sustained

[3] Perhaps that is the reason why, no FDI has gone to Kerala in RE sector.

development and growth in the wind energy more of GBI are recommended in contrast to capital incentives.

Elsewhere, Carley (2009), with focus on the empirical analysis of the U.S energy policy and the effectiveness of Renewable Portfolio Standard (RPS) finds that RPS is effective in increasing the overall installed capacity of RE. The study contends that the policy lacks focus on the share of each diversified categories of sources of RE generation.

Based on above brief literature review, it can be concluded that emphasis of most-studies is on only few states covering few policies. Moreover, the focus of these studies is on installed capacity but not on FDI. The paper bridges the gap as it looks the role of state level policies in attracting FDI for all the states having significant resource availability. The paper first constructs an index of attractiveness of a state with respect to wind policy and then associates it with FDI received in the state.

4. Methodology

As most natural resources fall under the Concurrent List, the respective State governments can decide their own energy policies. However, it is expected of State governments to align these policies to those set by the Central government. Given the different resource availability, different energy gap situation prevailing in different states, there would be heterogeneity in various policy parameters. This heterogeneity could mean that certain States could be adopting more investor attractive policy in comparison to the others to attract more FDI. The study explores the possible relationship between State level wind energy policies and the FDI received in the sector by the State.

As discussed later, an index for State level energy policy is computed. Using this index and controlling for other factors that could attract FDI to a particular State, following model is estimated:

$$FDI_{st} = \alpha + \beta Ix_{s,t} + \gamma X_{s,t} + \varepsilon_{s,t} \quad (1)$$

Where,

$$Ix_{s,t} = \text{Index of State's wind energy policy}$$

$X_{s,t}$ = Vector of State characteristics affecting FDI in the state

$\varepsilon_{s,t}$ = error term, comprising of two parts – a time invariant state effect and an independent and identically distributed random state-year term.

$$\varepsilon_{s,t} = \mu_s + v_{s,t}$$

β is the estimated parameter of State policy index and is predicted to have positive influence on the FDI inflow in wind energy sector. γ's are the coefficients of control variables. Some of the control variables include energy deficit in the state, per capita energy demand in the state, per capita income of the state, share of manufacturing in SDP, extent of grid connected energy in the state. The likely effect of these control variables is given later in the paper.[4]

For the given objective, there exist a variety of estimation models. However a simple pooled ordinary least squares (OLS) model would yield biased and inconsistent parameters if time invariant covariates are omitted. If omitted time-invariant variables are correlated with the policy incentive variables, a fixed effect (FE) model will provide a consistent and unbiased estimate of the parameters while simultaneously controlling for unobserved unit heterogeneity. On the other hand, if these omitted time-invariant variables are uncorrelated with the policy variable, a random effect (RE) model would provide a more efficient estimate than fixed effect model. Which of these assumptions is validated is tested by Hausman test.

4.1 Attractiveness of a state for wind power generation – Computation of index

As indicated earlier, different states in India have received FDI differently. One possible factor for attractiveness of a state for RE investment could be the enactment of pro-investor policies. Some of the key parameters for wind energy policy that may influence the decision of foreign investor are whether buy back is allowed and at what tariff rate, what are the wheeling charges, does the state have energy banking policy or does it has a provision for third party sale? What is the repurchase agreement in the state, besides the availability of common fiscal incentives like tax holidays etc?

To compare various policy measures across eight states in India, which have high wind potential, five policy parameters namely, tariff rate, wheeling charges, energy banking policy, permission for open access transmission and third party sale are used to compute a policy index for a state. These policy measures are designed by State Nodal Agencies and are implemented by the State Electricity Regulatory Commission of respective states. Table 2 gives a summary of these measures and the range of values across different states. It is to be noted that we do not include fiscal incentives and GBI given to investors as they are common across states.

4.2 Methodology in computing policy index

A composite index for five different wind energy policies / parameters is computed for a state. As the unit of measurement of parameters is different, normalization is done to aggregate them. Among the various techniques of normalization, the current study employs min-max criterion for normalization. Min-max method is based on the distance approach from the ideal. Index calculated based on distance approach tend to fare better in comparison to others (Sharma, 2010).

The index is constructed in two steps. Each policy variable is first individually considered and normalized. Each of the normalized parameter value is aggregated across time t for a

[4]Besides these obvious state-specific characteristics, FDI and wind energy policy may be dependent on some unobserved characteristics (Careley 2009). The relevance of these could have been if paper would have looked all RE resources. Given the focus of the present paper only on wind, especially in states which have the resource, there may not be any dependency on unobservable characteristics.

particular state. Final scores received by each state across time is normalized further to create the final index values. The normalization is done by min-max criteria.

$A_{is} = \frac{B_{is,actual} - B_{is,min}}{B_{is,max} - B_{is,min}}$.

$$Ix_{it} = \frac{\sum_{i=1}^{n} A_{it,actual} - \sum_{i=1}^{n} A_{it,min}}{\sum_{i=1}^{n} A_{it,max} - \sum_{i=1}^{n} A_{it,min}} \quad (5)$$

Where,

B_{is} = Value of parameter i for state s

A_{is}= Score received by each parameter i for state s

Ix_{it}= Score received by each state I for time period t

The parameters (Bis) considered are: tariff rates, wheeling charges, banking, open access and third party sale.

4.2.1 Tariff rates

Tariff Rate is the rate at which an operator can sell power if produced using wind energy. Broadly states adopt three different pricing strategies. First, where the tariff rate is fixed for the entire life of the plant/ project; second, where tariffs are fixed for the initial few years of the plant and then allowed per unit escalation in price over later period; and third, where unit escalation is allowed from the very first year of the plant life. Table 3 gives a summary of the tariff policy adopted by different states for two time period – 2003 and 2011.

As can be seen from the table, over the years states have moved from allowing escalation in wind tariff to adopting a levelized tariff over the life of the plant. In 2003, five states were having annual escalation clause, while constructing the relative index of the tariff, we have incorporated this annual revision. Since investment decision is governed by current policy, only immediate future is considered crucial in the current study. Accordingly, tariff rate for the first five year of the plant/project life is considered.[5] The per-unit cost in the second, third, fourth and fifth year was projected as per the wind energy policy of respective states. For example if a state allowed a 5% escalation in the unit cost of energy throughout the plant life, the tariff rate for the second year is considered as a 5% increase on the first year tariff rate and similarly for the third year and so on. An average of the first year and the fifth year is calculated. The calculated average tariff rate is then normalized using min-max criterion.

The state which offered high tariff rate reflects a pro-investor policy, and is assigned a value of one and vice versa. As can be seen from Table6, Maharashtra offered highest tariff over the seven year period followed by Rajasthan. Among the states having lowest tariffs are TN, Gujarat and Kerala. These states also practice a levelized tariff policy. Maharashtra, which received highest score for most of the years, a low index of 0.26 is observed for the year

[5]The choice of the fifth year is not arbitrary. As most states tend to revise their policies every fifth year, the choice is accordingly.

2009-10 because Rajasthan offered approximately a rupee more in per unit cost of energy (Table 6).

4.2.2 Wheeling charges

Wheeling Charge is the cost incurred by the producer to transmit energy produced to the designated utility. These costs are expressed in terms of percentage to the total energy transmitted. Some states in addition also charge for transmission losses incurred in the process of energy transmission. Broadly states have adopted wheeling charges in the range of 2% to 10% of the total energy transmitted.

Most of the States adopted a more producer friendly policies over the years by reducing wheeling charges as high as 10% of the total transmitted energy to less than equal to 5% of the total energy transmitted. For the year 2010-11 drastic changes in the score is observed. This change is due to the amendments in wind energy policy in most of the States. Discriminatory wheeling charges are also practiced in Gujarat and TN with lower wheeling charges imposed for transmission above 66KV and higher wheeling charges for transmission at less than 66KV.

To create an index for wheeling charges, the absolute wheeling percentage was considered. For states (for example MP) that charged for transmission losses a penalty was added. Various states followed varied practices with regard to charging an additional cost. Due to the heterogeneous practices adopted in imposing an additional charge, the current study has adopted an equal weight penalty across states. More specifically, a weight of 1 was added to the total score for those states with additional cost besides wheeling charges. The addition of the absolute wheeling percentage and added penalty together accounted for the total score. For example MP charges 2% as wheeling charge with an additional transmission charge. Hence the value 1 is added to 0.02 and the summation 1.02 is the non-normalized index value for MP. Table 7 summarizes wheeling charges imposed in various states and the revisions carried out in the last 8 years.

The total score was then normalized using max-min criterion. A score of one is assigned to the state with the least wheeling charge thereby indicating the most attractiveness and vice-versa. As can be seen from Table 8, most of the states revised their wheeling charges in 2010-11 affecting the relative index for the year.

4.2.3 Banking of energy

With respect to energy banking policies, there is a huge variation with some states allow banking throughout the year without restriction on the quantity of energy that can be banked while others place a restriction on the quantity and the duration for which the energy can be banked. Some states do not allow energy banking.

While constructing an index for banking in energy, three parameters where considered. (a)the number of months for which banking is allowed, (b) whether a restriction is placed on the quantity that can be banked, and (c) whether banking is allowed in February and March. An ideal banking period is when banking is allowed throughout the year with the provision of rolling energy banking over the months. Similarly, with respect to the quantity that can be banked, having no restriction whatsoever is ideal. Banking in February and March is an incentive for the energy producer with the financial year closing due on March 31st. Table 9 summarizes banking policies across states.

To factor these three parameters, share of banking period is obtained by dividing allowed banking months by 12 i.e., the total possible months. The ratio of quantity of energy banked is obtained by dividing quantity allowed by 100. An additional value of 1/3 is added if the particular state allowed banking in February and March. These three ratios are added and normalized using min-max criterion.

Table 10 indicates that banking of energy policies have changed radically over the years. For example, AP vacillated between full banking to no banking while MP shifted out from no banking to full banking. However, as is evident from the table, in 2010-11 most States have relaxed their policy towards banking.

4.2.4 Open Access Transmission and Third Party Sale

Open access transmission system requires owners to allow use of their transmission system by third party producers, whereas third party sales is allowing wind power to be sold to other parties besides utility and own captive use. Permission for open access and third party sale is assigned binary values. If open access is allowed a score of one is assigned and zero otherwise. Similarly if third party sale is allowed a score of one is assigned and zero otherwise. As can be seen from the table, over the years all the states except Kerala have allowed Open access transmission and Third Party sale of energy (Tables11and 12).

The discussion above indicates that wind energy policies are heterogeneous across States and over the years with diffusion in learning, policies have changed. The computed index being a relative score show stark variation across states. The sudden drop/ rise in the index values between two consecutive period may be due to a more favorable policy change in other states and may not necessarily imply a perverse policy being adopted by the State itself (Table 13).

As mentioned earlier FDI in RE resources is concentrated in three States of India, namely Maharashtra, Karnataka and TN. Figure 6 gives a simple graph between policy index of these states and FDI inflow. It is observed than when policy index rise, FDI inflows increase. Interestingly, in spite of high index of MP and Rajasthan, these states are not a destination for FDI investments yet. On the contrary, even during phase of decreasing policy index in Karnataka, the State was successful in attracting FDI during the same period (Figure 7).This points that besides policies, there may be other characteristics influencing FDI inflow in a state.

5. Data and variables

The data set used for the study is annual data and spans seven years from 2004-05 to 2010-11. As indicated the FDI in a state is not only affected by policy but also by some state-specific variables, such as per capita income of the state, energy deficit, share of manufacturing and Grid connectivity etc, they have been used as control variables.

5.1 Control variables

Market Size: A bigger market attracts FDI. This is due to large potential demand and thereby economies of scale (Walsh and Yu, 2010). The market size is measured by per capita net state domestic product (NSDP) (Lnpercapita). However, pertaining to FDI in wind, the interpretation of the variable changes as high per capita income may reflect greater ability of people to pay for the RE tariff, which still are higher than the conventional energy sources. A bigger market size is hypothesized to have a positive sign.

Manufacturing Share: SDP accrues from the primary (agricultural), secondary (manufacturing) and the tertiary (services) sector. The manufacturing sector is relatively more capital intensive contrary to the agriculture and the services sector. A state with higher manufacturing share is expected to have higher power demand and therefore would attract more FDI. In fact, higher energy requirement by manufactures especially the cement have led to captive wind power producers in states like TN. Therefore the current study uses the manufacturing share (Manushr) as a control variable.

Demand for power: Per capita power consumption (Powercon) is used as a measure of demand for power. A state with higher power consumption would attract more FDI. The case for this is strong as all the states considered in the study report power deficits. Higher energy deficit in a state is hypothesized to attract FDI. Fluctuation in energy deficits runs across all the States with increase in energy deficits observed over the period (Table 2). Maharashtra (a state with the highest NSDP) and the MP (a State with low NSDP) suffer from on an average 18% deficit in energy. TN despite pioneering in wind installed capacity suffers from energy deficits of over 6.5% in last four years (Table 2).

Infrastructure: Good grid connectivity (Grid) will support transportation of energy produced. It also reduces evacuation cost of the producer. Therefore a good infrastructure will attract FDI (Jagadeesh 2000).Grid connectivity is hypothesized to have a positive sign.

Clustering effect: An existing stock of FDI allows positive spillovers through linkages. They are also indicative of conducive conditions for foreign investment. Apart for market size, institutional characteristics like governance, political stability, and corruption are crucial in foreign investment in transmission economies. Proposed investment is used as a measure of readiness of State in attracting investment. Higher proposed investment in a state will attract more FDI until the congestion cost exceeds the cost of relocating (Adersa and Ray, 1998)

5.2 Descriptive Statistics

Table 14 gives the mean values of different variables used in the analysis. The mean per capita SDP (column 2) in Maharashtra, Gujarat, Kerala and TN is above the sample mean and these states are more likely to attract FDI. However, FDI inflows across these states have varied greatly from zero in Kerala to Rs. 19.17 cr in TN to Rs. 247 cr in Karnataka to Rs 1685.42 cr in Maharashtra. Though Maharashtra and Gujarat are the only states with the all the characteristic above average, both have very high power deficit. AP falls below the sample average in per capita SDP, manufacturing share, per capita power consumption and grid connectivity. Kerala though has a high per capita SDP, the manufacturing share is only 7 per cent and correspondingly lowest per capita power consumption with limited grid connectivity and proposed investment. With the Electricity act of 2003, and its focus on grid connected RE and support to this initiative by the National Tariff Policy of 2005, grid connectivity has grown manifold in the last 7 years (column 5). The maximum growth is in Kerala which had limited grid connectivity in 2005.

Interestingly TN state has high per capita SDP and high per capita power consumption with a manufacturing share of over 15 per cent, but has hardly received any FDI in wind. One probable reason could be low power deficit in the state during the period (column 6). Columns 3 and 4 give the share of manufacturing and per capita power consumption in the states and also respective growths. Per capita power consumption has increased over the years with minimum CAGR in Maharashtra (3.3 per cent) and maximum in Kerala (5.9%).

6. Econometric analysis

Before estimating the model, we first see correlation between different control variables. Table A1 in appendix gives the correlation matrix and also gives significance of the correlation coefficient at minimum 5 per cent level. We find that a state with higher per capita income is having higher power consumption, grid connectivity and also higher manufacturing share. Consequently we could not use all the controlled variables together.

We first estimated equation 3 by pooling the data for all the states (pooled OLS). As discussed, due to omitted variables, the OLS results will be biased, we need to use panel data techniques. Subsequently we ran both – fixed effect (FE) and random effect (RE) models. First we do F-test to see whether individual fixed effect exists or not. Since F value (4.33) is greater than the tabulated value, this implies we reject the null hypothesis (i.e., model is pooled OLS). This implies we need to do FE and RE. Columns 2 and 3 of the table give FE and RE estimates. Whether these omitted variables (state-specific differences) are fixed or random are tested using Hausman Test as given in the last row of Table 15. Since the tests statistic 2.28 is less than the critical value of a Chi-squared (1df, 5%) (3.84), we accept the null of RE being more efficient. To see whether RE exist, we do another test (Breush-Pagan Lagrange-Multiplier test). Reject null hypothesis (i.e. there are individual random effects), Since *LM* value (10.37) is larger than the critical value, we reject the null, thus there exists the random effect.

Subsequently, we interpret only RE model. As can be seen from row 1, policy index has a positive and statistically significant effect on FDI investment. At the mean value of per-capita income and energy deficit, a 10 per cent increase in policy index from 0.66 to 0.73 would result in addition 1 crore of FDI. With respect to control variables, a state having high per captia income is able to attract more FDI. The power deficit in the state however fails to have any impact on the investment decision in case of FDI.

In order to see whether results are robust to the inclusion of control variables, we carry out RE model with dropping of these control variables. Table 16 gives the results where some of the control variables are either dropped or alternate control variables are used. Column 2 reports the results when per capita power consumption is used instead of per capita income. The impact of policy index variable remains same. Column 3 of the table uses only deficit variable apart from the policy index variable. In column 4, we use only the policy index variable. The sign and significance of policy index variable does not change. The results are thus robust to non-inclusion of control variables.

Based on the results, we can conclude that favourable wind policy facilitates FDI in the state.

7. Conclusions

This paper computes state-specific wind policy index that reflects policies to attract wind power generation in the state. For computing the index, five key policies in wind RE are feed-in-tariff, open access transmission, third party sale, banking, and wheeling charges. In order to see the role of institutional differences, a policy index is created. Panel data techniques are then employed to investigate the impact of the policy differences on renewable FDI for the 8 states over the seven year period (2004-05 to 2010-11) after controlling for several state-specific factors. The controlling factors include per-capita income of the state, grid connectivity, per capita power consumption, power deficit, and share of manufacturing in the SDP. The results indicate that state-specific policy index for wind RE is significant in attracting FDI in a state irrespective of whether control variables are included or not. Higher per capita power consumption or per capita income is an indication of better performing states, thereby facilitate FDI apart from the state-policy index. On the other hand, the power-deficit situation in a state does not guarantee that it will attract FDI. Our results for state-specific policy index remain robust even if we introduce state-specific dummy instead of control variables. The study thus demonstrates the important role of policies in influencing RE FDI.

The paper indicates several avenues for future research. The role of policies can be seen for other renewable energy sources also – such as policies to attract solar energy generation or biomass etc. Since states have received more domestic investment than FDI, another extension of the paper would be to see whether FDI and domestic investment have complemented each other or private investment has substituted FDI in the sector.

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Figures

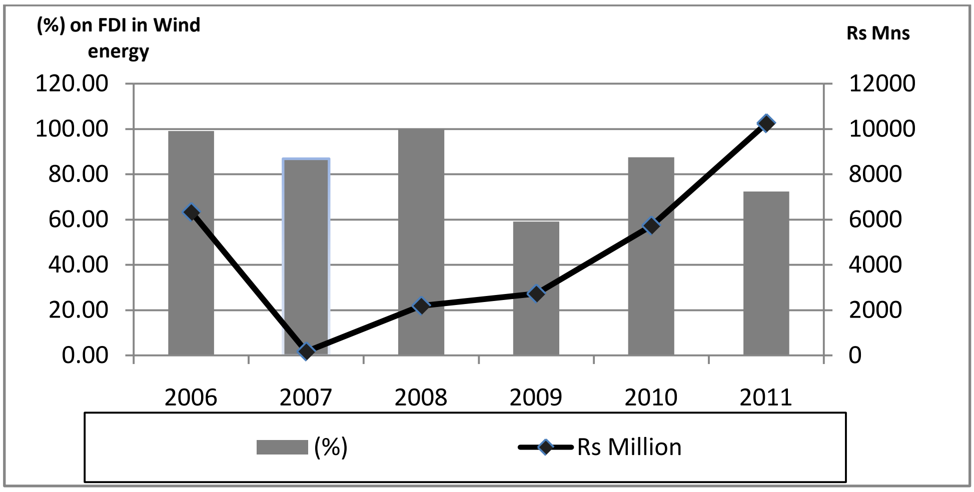
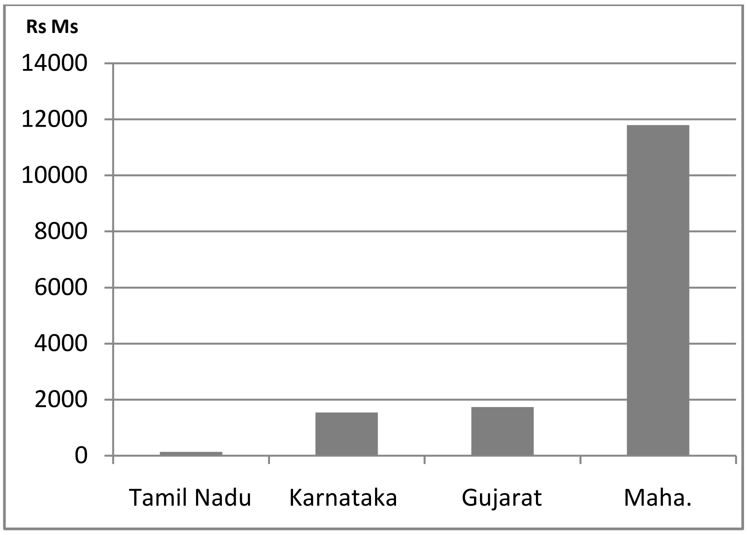
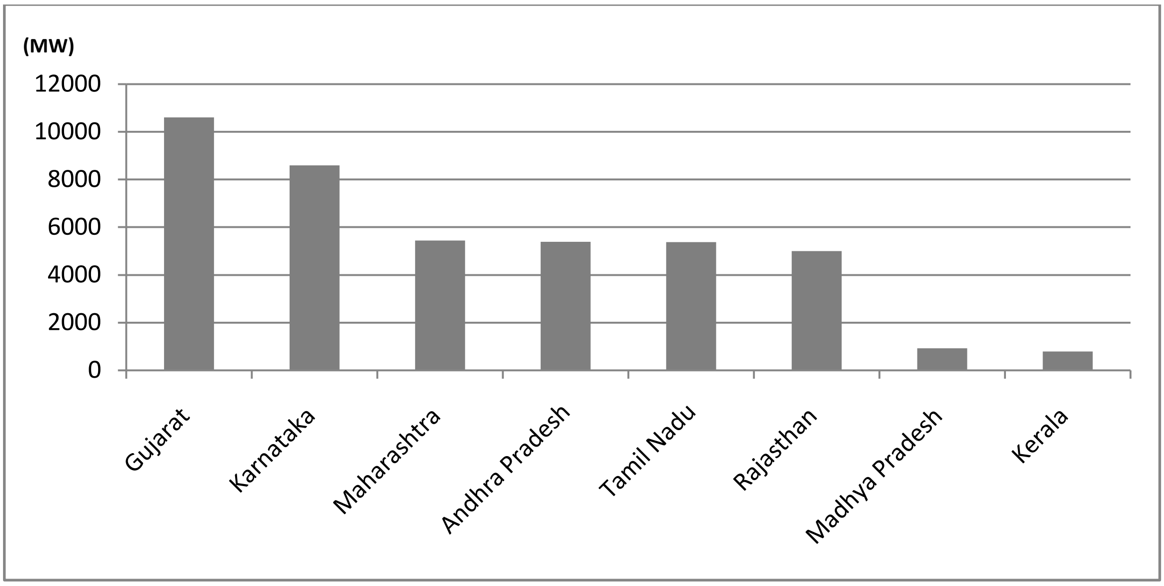


Figure 1: Trend in share of FDI inflows to wind energy of total FDI inflows to renewable energy



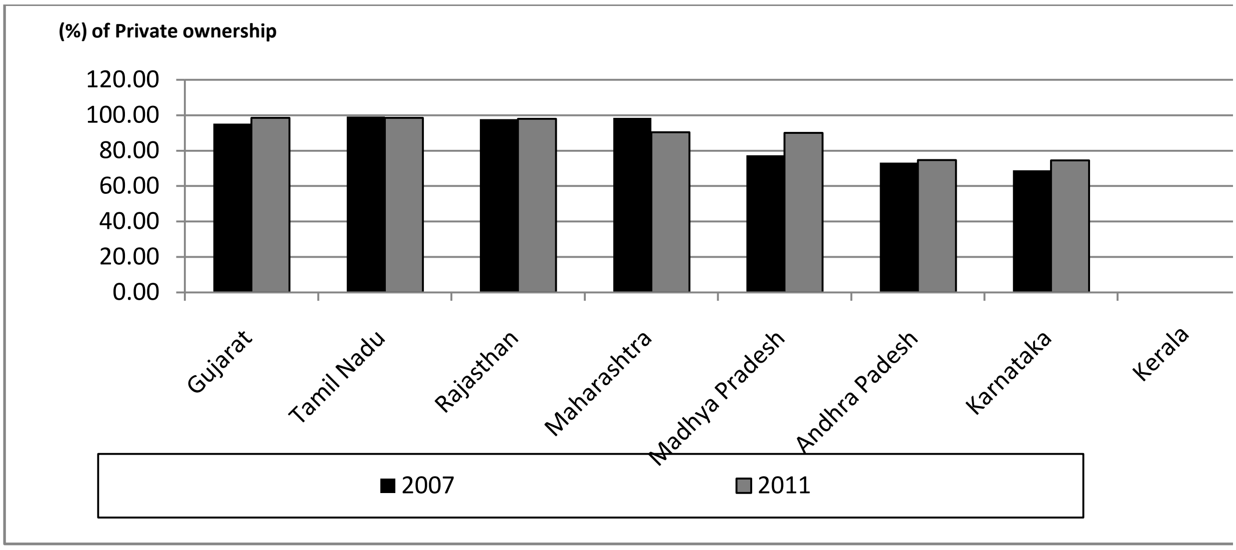
Source: Compiled from SIA Newsletter- Various Issues

Figure 2: Cumulative FDI in wind energy from 2004-05 to 2010-11



Source: C-WET as accessed on 14:08:2012

Figure 3: Estimated wind Potential in various Indian states-C-WET (MWs) at 50m Height



Source: Annual report 2011-12 on the Working of State Power Utilities and Electricity Departments

Figure 4: Share of Private ownership in total installed capacity in Renewable energy resources

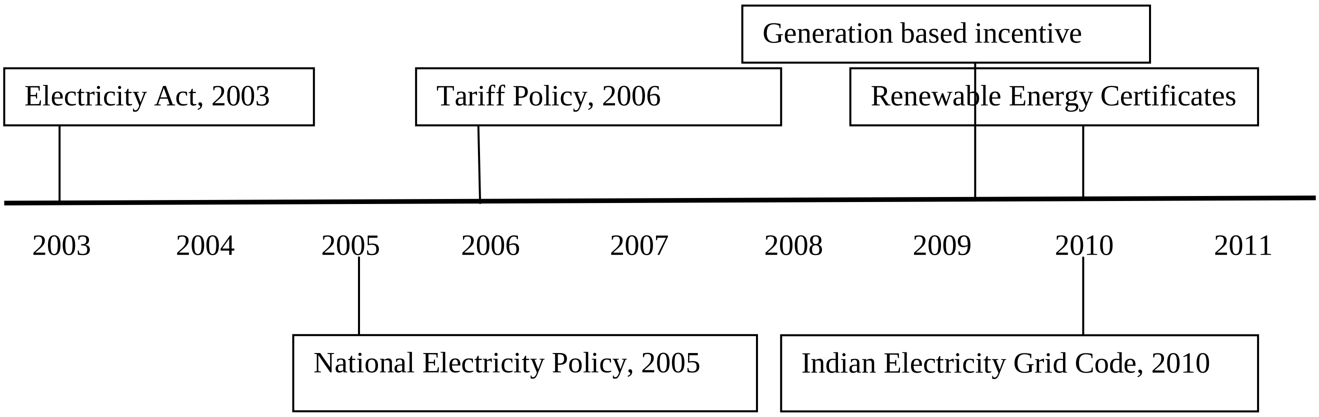


Figure 5: Timeline of policies pertaining to wind energy

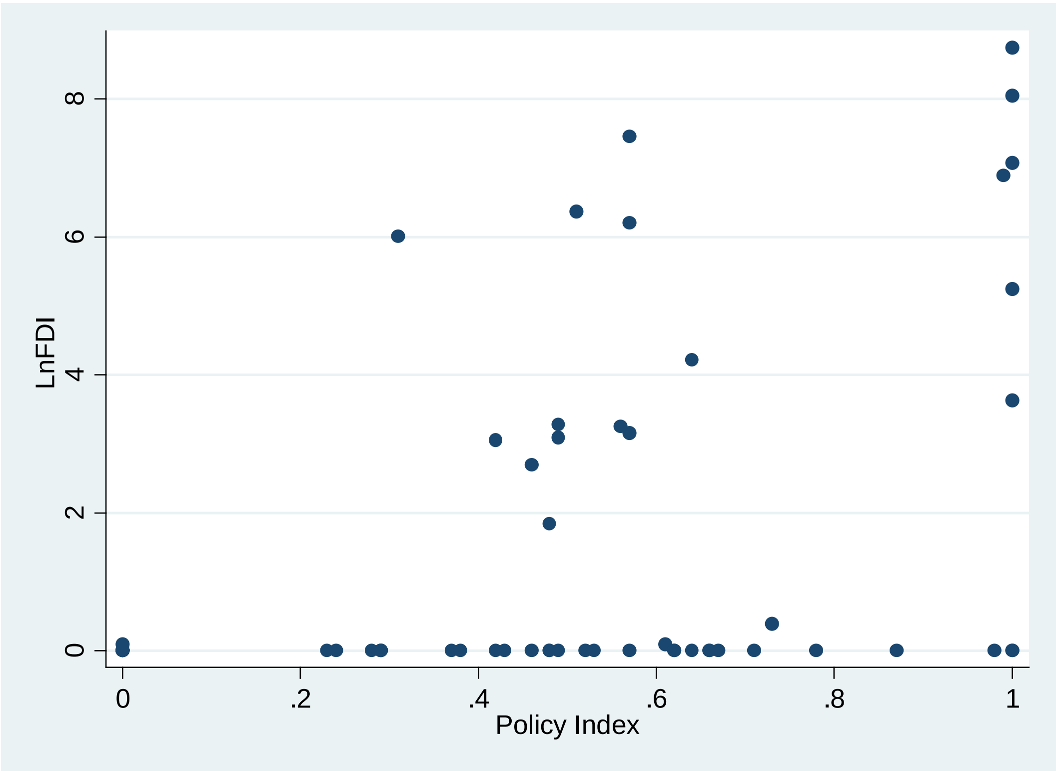
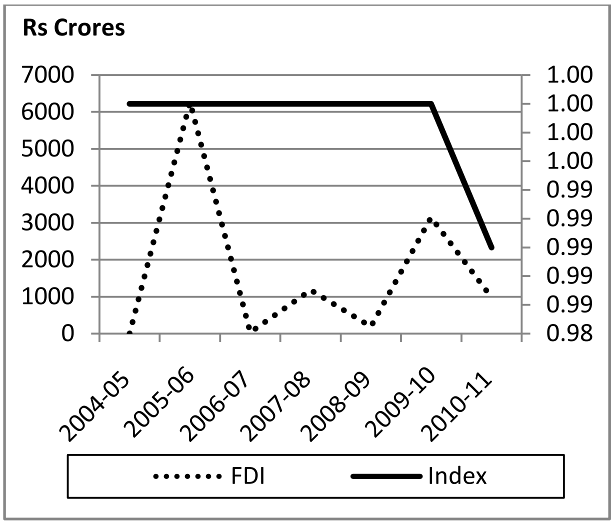
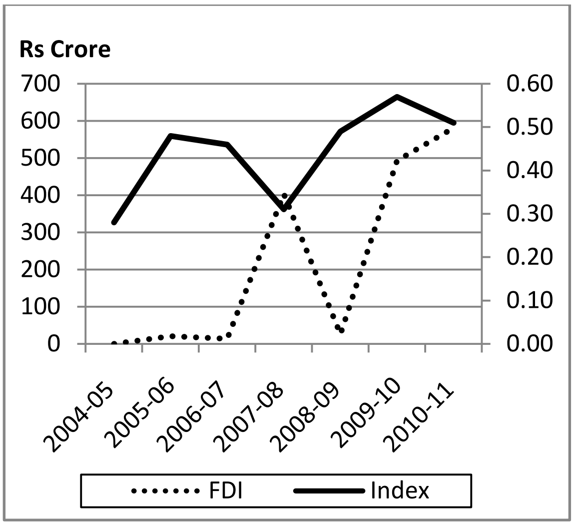


Figure 6: Wind energy policy index vs. FDI inflow

Maharashtra



Karnataka



Tamil Nadu

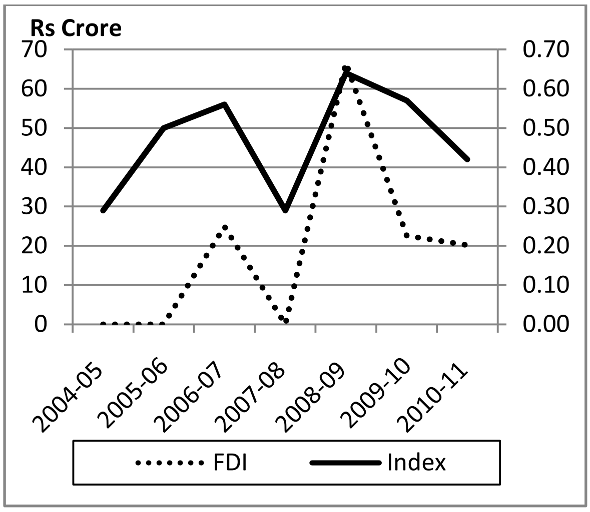


Figure 7: Wind energy policy index vs. FDI inflow in three key states

Table1: Distribution of FDI among various renewable energy resources

Year	Wind		Solar		Biogas		Nonconv Source# Rs. Cr.	Total FDI (Rs. Cr.)
	RsCr.	Share (%)	RsCr.	Share (%)	RsCr.	Share (%)		
2004	..	..	..	..	..	..	11.11	41480
2005	..	..	..	..	..	..	0.6	687413
2006	6326.49	99.07	0.5	0.008	34.81	0.54	24.33	327994
2007	169.9	86.93	25.54	13.07	..	..	..	357098
2008	2186.47	100.00	..	0	..	..	..	829928
2009	2722.34	59.09	..	0	..	..	1884.99	848021
2010	5729.37	87.43	246.79	3.77	509.36	7.77	67.35	610537
2011	10249.21	72.39	1487.69	10.51	38.71	0.27	2382.03	927333

Note: # - From 2004 onwards, SIA started giving FDI separately for each of the non-conventional resource. Earlier, everything was clubbed under non-conventional energy sources.

Source: Compiled from SIA Newsletter- Various Issues

Table 2: Summary of energy policies studied

Policy Variable	Description	Range	Remark
Tariff Rates	Per unit cost of wind energy produced	2004-05:Rs 2.75 (TN) to Rs 3.80 (Maharashtra) 2010-11: Rs 3.14 (Kerala) to Rs 4.35 (MP)	An increasing trend of adopting levelized per unit cost is observed.
Wheeling Charges	Charges imposed on the producer for transmission of energy	2004-05: 2% of the energy (AP and Maharashtra) – 12% of the energy (Karnataka) 2010-11: 2% of the energy + Transmission Charges (Maharashtra) – 7% of the energy (Rajasthan)	Wheeling charges have declined with discriminatory charges imposed on high, medium and low transmission channels.
Banking of Energy	Allows withdrawal of energy in the event of emergency or shut down or maintenance of plant	No banking to Full Banking	Allowed in all states. Some states do not allow banking through the month of Feb- Mar.
Open Access Transmission	Requires transmission system owners to allow use of their transmission system by third party producers	Not Allowed – Allowed	Allowed in all states
Third Party Sale	Allowing wind power to be sold to other parties besides utility and own captive use	Not Allowed – Allowed	Allowed in all states except in Kerala

Source: Own compilation from different sources

Table 3: Summary of Wind Tariff

State	AP		Gujarat		Karnataka		Maharashtra		MP		TN		Rajasthan		Kerala	
Year	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**
Tariff (Rs/ kwh)	2.25	3.5	2.6	3.56	2.25	3.7	2.25	4.29-2.86	2.25	4.35	2.7	3.39	2.89	3.87 - 4.08	2.8	3.14
Policy	5% ^ (1994-95)	L for 10yrs	0.05^ per unit	L	5%^	L for 10 yrs	5%^	L	L	L	L	L	5%^	L	5% ^ first5 years	L
No of Revi-Sions	**4** (2001-02,2003-04,2004-05,2008-09)		**2** (2007-08,2010-11)		**3** (2004-05,2007-08,2010-11)		**3** (2003-04,2007-08,2010-11)		**3** (2004-05,2008-09,2010-11)		**4** (2004-05,2006-07,2008-09,2010-11)		**5** (2004-05,2007-08,2008-09,2009-10,2010-11)		**1** (2005-06)	

Notes: L – Levelized tariff, ^ - escalation; When time duration is not specifically mentioned implies the same policy is followed through the life of the plant, for example, 5% ^ 1994-95 means a 5% increase through the life of the plant starting 1994-95 onwards.

Table 4: State wise index for tariff rates

Year	AP	Gujarat	Karnataka	Kerala	MP	Maharashtra	Rajasthan	TN
2004-05	0.61	0.00	0.53	0.35	0.85	1.00	0.68	0.05
2005-06	0.59	0.00	0.47	0.39	1.00	0.97	0.73	0.04
2006-07	0.62	0.00	0.38	0.41	0.85	1.00	0.69	0.20
2007-08	0.52	0.52	0.56	0.27	0.82	1.00	0.86	0.00
2008-09	0.35	0.35	0.39	0.00	0.46	1.00	0.86	0.38
2009-10	0.17	0.17	0.19	0.00	0.22	0.26	1.00	0.18
2010-11	0.30	0.35	0.46	0.00	1.00	0.95	0.78	0.21
Average	**0.45**	**0.20**	**0.43**	**0.20**	**0.74**	**0.88**	**0.80**	**0.15**

Source: Own computation

Table 5: Summary of Wheeling Charges

State	AP		Gujarat		Karnataka		Maharashtra		MP		TN		Rajasthan		Kerala	
Year	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**
Wheeling Charges	2%	As per SERC	4%	4.4% (>66 kv) and 10% (>66 kv)	20%	5%	2%	As per SERC	2%	2% + Transmission charges	5%	5% >66 kv) and 7.5% (<66 kv)	2%	50% of the normal transmission charges	5%	5%
No of Revisions	**1** (2008-09)		**1** (2010-11)		**2** (2004-05, 2008-09)		**2** (2007-08, 2008-09)		**1** (2004-05)		**1** (2010-11)		**2** (2004-05, 2010-11)		**0**	

Note: SERC - State Electricity Regulation Commission

Table 6: State wise index for wheeling charges

Year	AP	Gujarat	Karnataka	Kerala	MP	Maharashtra	Rajasthan	TN
2004-05	1.00	0.75	0.13	0.63	0.88	1.00	0.00	0.63
2005-06	1.00	0.75	0.13	0.63	0.88	0.88	0.00	0.63
2006-07	1.00	0.75	0.13	0.63	0.88	0.88	0.00	0.63
2007-08	1.00	0.75	0.13	0.63	0.88	0.88	0.00	0.63
2008-09	0.63	0.75	0.63	0.63	0.88	0.88	0.00	1.00
2009-10	0.71	0.86	0.71	0.71	1.00	1.00	0.00	0.71
2010-11	0.50	0.32	0.40	0.20	1.00	1.00	0.00	0.20
Average	**0.83**	**0.70**	**0.32**	**0.58**	**0.91**	**0.93**	**0.00**	**0.63**

Source: Own computation

Table 7: Summary of Banking Policy

State	AP		Gujarat		Karnataka		Maharashtra		MP		TN		Rajasthan		Kerala	
Year	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**	**2003**	**2011**
Banking	12 ms	A.	6 ms	1ms	2% (12 ms)	2% (12 ms)	12 ms	12 ms	No	A	5% (12 ms)	5% (12 ms)	12 ms	6 ms	9 ms (Jun.-Feb) not allowed	
No of Revisions	**1** (2008-09)		**2** (2008-09, 2010-11)		**1** (2010-11)		**0**		**1** (2008-09)		**0**		**2** (2007-08, 2010-11)		**0**	

Notes:ms- Months, A – Banking Allowed; Figure in parenthesis is the quantity of allowed for banking

Table 8: State wise index for banking in energy (1 – Yes, 0 – No)

Year	AP	Gujarat	Karnataka	Kerala	MP	Maharashtra	Rajasthan	TN
2004-05	1.00	0.79	0.58	0.75	0.00	1.00	1.00	0.59
2005-06	1.00	0.79	0.58	0.75	0.00	1.00	1.00	0.59
2006-07	1.00	0.79	0.58	0.75	0.00	1.00	1.00	0.59
2007-08	1.00	0.61	0.58	0.64	0.00	1.00	0.36	0.59
2008-09	0.00	0.61	0.58	0.75	1.00	1.00	0.68	0.59
2009-10	0.00	0.46	0.58	0.75	1.00	1.00	0.68	0.59
2010-11	1.00	0.06	0.00	0.41	1.00	1.00	0.49	0.03
Average	**0.71**	**0.59**	**0.50**	**0.69**	**0.43**	**1.00**	**0.74**	**0.51**

Source: Own Computation

Table 9: State wise index for open access transmission

Year	AP	Gujarat	Karnataka	Kerala	MP	Maharashtra	Rajasthan	TN
2004-05	0	0	0	1	0	0	1	1
2005-06	1	0	1	1	1	1	1	1
2006-07	1	0	1	1	1	1	1	1
2007-08	1	1	1	1	1	1	1	1
2008-09	1	1	1	1	1	1	1	1
2009-10	1	1	1	1	1	1	1	1
2010-11	1	1	1	0	1	1	1	1
Average	**0.86**	**0.57**	**0.86**	**0.86**	**0.86**	**0.86**	**1.00**	**1.00**

Source: Own Computation

Table 10: State wise index for third party sale (1 – Yes, 0 – No)

Year	AP	Gujarat	Karnataka	Kerala	Maharashtra	MP	Rajasthan	TN
2004-05	0	0	1	0	1	1	1	0
2005-06	0	0	1	0	1	1	1	1
2006-07	0	0	1	0	1	1	1	1
2007-08	0	1	1	0	1	1	1	1
2008-09	1	1	1	0	1	1	1	1
2009-10	1	1	1	0	1	1	1	1
2010-11	1	1	1	0	1	1	1	1
Average	**0.43**	**0.57**	**1**	**0**	**1**	**1**	**1**	**0.86**

Source: Own Computation

Table 11: State wise policy index for Wind energy

Year	**AP**	**Gujarat**	**Karnataka**	**Kerala**	**MP**	**Maharashtra**	**Rajasthan**	**TN**
2004-05	0.43	0.00	0.28	0.48	0.48	1.00	0.87	0.29
2005-06	0.62	0.00	0.49	0.37	0.71	1.00	0.66	0.52
2006-07	0.62	0.00	0.46	0.38	0.66	1.00	0.64	0.56
2007-08	0.42	0.57	0.31	0.00	0.49	1.00	0.29	0.29
2008-09	0.24	0.53	0.49	0.00	0.78	1.00	0.46	0.64
2009-10	0.23	0.57	0.57	0.00	0.98	1.00	0.67	0.57
2010-11	0.73	0.48	0.51	0.00	1.00	0.99	0.61	0.42
Average	**0.47**	**0.31**	**0.44**	**0.18**	**0.73**	**1.00**	**0.60**	**0.47**

Source: Own Computation

Table 12: Energy deficits expressed as a percent to the total energy required

Year	**Maharashtra**	**AP**	**TN**	**Gujarat**	**Karnataka**	**Kerala**	**MP**	**Rajasthan**
2004-05	-16.8	-2.3	-1.2	-25.4	-5.3	-1.3	-18.5	-7.8
2005-06	-18.1	-1.3	-0.6	-8.2	-0.7	-0.7	-14.2	-3.7
2006-07	-19	-4.4	-1.7	-30.2	-2.1	-2.1	-20.1	-14.6
2007-08	-18.3	-4.1	-2.8	-16.2	-2.7	-2.4	-14.1	-3.1
2008-09	-21.4	-6.8	-7.8	-9.8	-6	-11.8	-17.2	-1.1
2009-10	-18.7	-6.6	-6.2	-4.5	-7.7	-2.4	-19	-2.4
2010-11	-16.6	-3.2	-6.5	-5.7	-7.6	-1.4	-20.2	-0.9
Average	**-18.4**	**-4.1**	**-3.8**	**-14.3**	**-4.6**	**-3.2**	**-17.6**	**-4.8**

Notes: AP – Andhra Pradesh, TN – Tamil Nadu, MP – Madhya Pradesh

Source: Central Electricity Authority

Table 13: Mean values of control variables

State	FDI (Rs. million)* (1)	Per Capita NSDP (Rs) (2)	Share of Manufacturing (%) (3)	Per capita Power consumption (kwh) (4)	Grid Connected (Mw) (5)	Power Deficit (%) (6)	Prop. Inv (Rs Cr.) (7)
AP	0.068	32694.14	8.6 (-2.2)	867.12 (4.8)	139 (12.97)	-4.1	85606.71
Gujarat	247.7	42013.29	20.16 (0.6)	1441.06 (4.6)	1499.20 (39.4)	-14.3	101971.3
Kerala	0	40356.3	7.03 (2.96)	457.38 (5.9)	20.45 (152.7)	-3.2	448.14
Karnataka	219.88	34193.14	14.02 (0.05)	816.79 (6.5)	1271.89 (20.6)	-4.6	82095.43
MP	0	18419	9.70 (9.57)	584.09 (3.4)	192.62 (67.3)	-17.6	80223.71
Maharashtra	1685.42	49256	18.22 (5.97)	976.38 (3.3)	1915.26 (11.8)	-18.4	78654.00
Rajasthan	0.1	22176	10.97 (6.43)	665.38 (5.0)	872.06 (34.8)	-4.8	13506.57
TN	19.17	40889.57	15.39 (3.7)	1073.91 (4.4)	4496.3 (14.1)	-3.8	36945.14
Mean	**271**	**38382.98**	**14**	**917.90**	**1131.36**	**-8.84**	**59931.37**

Notes: *Mean of the dependent variable; figures in parenthesis are compound annual growth rate of variable over 2005 to 2010.

Table 14: Does wind policy influence FDI?
(Dependent variable = ln(FDI))

VARIABLES	Pooled OLS (1)	FE (2)	RE (3)
Polindex	3.974*** (0.739)	1.663 (1.272)	2.681** (1.062)
lnpercapita	4.333*** (0.576)	5.183*** (1.426)	4.622*** (1.071)
deficit	0.0152 (0.0254)	-0.0215 (0.0509)	0.00480 (0.0423)
Constant	-45.68*** (6.031)	-53.00*** (14.76)	-47.92*** (11.16)
Observations	56	56	56
R-squared	0.509	0.282	0.48
F-test/Wald chi-square	21.02 (0.00)	5.9 (0.002)	26.4 (0.00)
Number of States		8	8
Hausman Test		2.28 (0.51)	

Table 15: Are the results robust? – State-specific Wind Policy influence on FDI

(Dependent Variable = ln(FDI))

VARIABLES	Model 1	Model 2	Model 3	Model 4
Polindex	2.681** (1.062)	2.531** (1.161)	2.793** (1.249)	2.852** (1.227)
Lnpowercon		5.184*** (1.607)		
Deficit	0.00480 (0.0423)	-0.00645 (0.0466)	-0.00771 (0.0501)	
Lnpercapita	4.622*** (1.071)			
Constant	-47.92*** (11.16)	-34.36*** (10.79)	0.226 (1.120)	0.127 (0.949)
R-square	0.48	0.27	0.17	0.18
Observations	56	56	56	56
Number of States	8	8	8	8

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Appendix

Abbreviation

Polindex = Index created for state policies

Powercon = Per capita power consumption in the state (in log)

Percapita Income = Per capita Gross state Domestic Product (in log)

Grid = Grid connected renewable energy resources (ln log)

Deficit = Energy Deficit (surplus) in the state as a share of total energy

Manushr = Manufacturing share of the state to Gross State Product at constant prices

Propinvt = Proposed investments in the state (in log)

Spearman Rank Correlation Matrix

	Polindex	Powercon	Percapita	Grid	Deficit	Manushr	Propinvt
Polindex	1						
Powercon	0.0855	1					
Percapita	-0.0335	0.5930*	1				
Grid	0.3009	0.7673*	0.4771*	1			
Deficit	0.4057*	0.2428	0.0877	0.0995	1		
Manushr	0.2219	0.8139*	0.4229*	0.8079*	0.3667	1	
Propinvt	0.2552	0.6439*	0.2972	0.4390*	0.3603	0.4586*	1

Note: * indicates significance of correlation coefficient at minimum 5% level.