THESIS

THE INTERNATIONAL BARRIERS TO RENEWABLE ENERGY DEVELOPMENT

Submitted by

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY COLTER H. KINNER ENTITLED THE INTERNATIONAL BARRIERS TO RENEWABLE ENERGY DEVELOPMENT BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS.

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ABSTRACT OF THESIS

THE INTERNATIONAL BARRIERS TO RENEWABLE ENERGY DEVELOPMENT

Renewable energy is increasingly seen as a possible solution to problems such as climate change, population growth, economic development, and the limitations of traditional energy sources. Existing research on the international barriers to Renewable Energy Development (RED) is relatively dispersed and has not been subjected to empirical testing. This paper argues that the largest barrier to RED is a lack of enabling policies and regulatory frameworks. Using the degree of state interventionism as a proxy for enabling policies and regulatory frameworks, this paper expects a curvilinear relationship between government ownership of enterprise and RED. A cross national statistical analysis for the 1990-2006 period finds empirical support for many of the proposed barriers to RED. This paper provides researchers and policy makers alike with a better understanding of the international barriers to RED.

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Introduction:

The issues surrounding energy play an increasingly salient role in the study of international relations and environmental politics and policy. Increasing oil prices and growing demand for energy on the global scale have shaped an environment in which renewable energy development is becoming more relevant. On the international stage, much variation in levels of renewable energy development exists, with some states having relatively sophisticated levels of renewable energy development and others exhibiting little progress. Yet little work on this subject exists in the field of Political Science. By examining barriers to renewable energy development across different countries, this research attempts to explain why some countries are more likely to invest in renewable energy than others.

To put this all into context, it is helpful to start with two illustrative examples. The United States currently exhibits relatively low levels of RED (the U.S. scores a .016 on the Renewable Energy Index presented later). However, the United States is one of the most developed countries in the world and scores a perfect score on the GDP Index of the United Nations Development Programme (UNDP, 2009). This is particularly puzzling because countries ranked lower on the GDP Index have higher levels of RED. For example, a country like Mozambique, which is said to exhibit a low level of human development, currently has over 10 times the level of renewable energy development than that of the U.S. (Mozambique scores a .23 on the Renewable Energy Index). Why is

it that an economic powerhouse invests so little in RED compared to a much poorer country?

These two examples illustrate concerns immediately relevant for this project. While the political, social, and economic circumstances surrounding each of these situations could not be more different, these examples reveal two insights for the study of RED. Few would guess that Mozambique has higher levels of RED than the U.S. Further, the examples of countries that are struggling are much more common than those that have done well. In an increasingly interconnected world, the overall lack of countries with significant renewable energy portfolios indicates that there may be barriers that the struggling countries share in common. What are variables that can explain RED successes and failures?

Renewable energy is generally assumed to be normatively beneficial. Part of what makes the general lack of renewable energy portfolios internationally so puzzling is that renewable energy is a solution to a number of problems. Renewable energy can provide for social, environmental, and economic welfare. Additionally, the development of renewable forms of energy could provide a sustainable way for the developing world to make progress, provide for a larger global population than the increasingly scarce traditional forms of energy, and reduce the rate of emissions of greenhouse gases associated with those traditional forms of energy. Undoubtedly, the actualization of these theoretical propositions is a question that goes far beyond the scope of this paper and will be left for the time being. However, the overall favor that renewable energy seems to find combined with its relative scarcity suggests that there exists a need to empirically examine the obstacles to something that is almost universally seen as beneficial. With

this in mind, this project asks: what are the international barriers to renewable energy development?

Research on the barriers to Renewable Energy Development (RED) is important in a number of ways. This paper makes several contributions to earlier research. First, much of the work on the topic up and to this point has been qualitative in nature. While there is great value in this research, there is a need to quantitatively evaluate the international barriers to renewable energy development for several reasons. Second, this research will add an element that has been missing to a body of knowledge and understanding about RED. By exploring and then evaluating the existing conceptual and theoretical work in the field, this work will be able to indicate to scholars if any of the proposed barriers are cross-nationally significant. In doing so, the empirical identification of significant barriers also indicates where scholars should focus their research efforts. Finally, it entertains the possibility of directing policy makers to the most appropriate areas for policy development in the immediate future.

This work will start by examining the literature on the topic and sketching the contours of extant scholarly understandings. After uncovering some of the main strands of thought on the subject, it will move on examine the logic of these arguments. Thereafter, this work will make the argument that the largest international barrier is a function of enabling policies and regulatory frameworks. This paper expects that the level of enabling policies and regulatory frameworks, measured here by degree of state interventionism, explains RED internationally in a curvilinear relationship. The paper then proposes a research design for a quantitative analysis of the barriers to renewable energy.

Literature Review:

The literature on renewable energy is disjointed. The discussion is far from developed and comes from a number of different fields. In fact, some of the separate conversations do not even seem to engage one another. That said, after providing a historical analysis to set the stage, this work will attempt to pull apart the conversation and identify the main strands of thought on the subject. This work will start by examining the most significant discussion found in the literature. In looking at the debate between technological and market approaches, this work will examine how each approach developed and where each stands today. After discussing the advances that have taken place within this debate, this paper will then inspect two other significant strands of work that came out of this period. In then examining the 'kitchen sink' and the 'context specific' perspectives, this project will highlight the most relevant strands of thought for this work.

There are a couple of early works on the subject that set the stage for much of the contemporary thinking. In some of the older studies on renewable energy, the linkages between energy consumption and economic development were used for making normative arguments for renewables (see, for example, Ali, 1981). Further, despite differing opinions about the potential effects of those linkages, Renewable Energy Technologies (RET's) were seen as a solution to the developing world's woes. Goldemberg, for example, argued of developing countries that, "…they do not have to reach high values of the E/GDP ratio even in their initial stages of industrialization because they can benefit from the modern methods.." (ibid, 16). Clearly, renewable

energy found normative support and the relationship between energy consumption and economic development was a crucial aspect of the early conversation.

As time progressed, a discussion of the obstacles to RED began to develop. As Clay observed, there are a variety of obstacles including costs, infrastructure, incentives and policies that can act as barriers between developing countries and renewable energy (2002, 30). Clay's evaluation qualitatively examines the technical, educational, economic, and cultural barriers to renewable development. Clay concluded that the industrialization and urbanization of developing countries leads to increased energy needs and that "because so many areas in developing countries still lack any substantial energy programs at all, the time is ripe to develop and implement projects that depend on renewable rather than nonrenewable energy sources from the start" (ibid, 33). This conclusion became a common refrain in the literature and reiterated the justifications in favor of renewable energy found in the economic development discourse.

A dialogue surrounding technology and the market also played a noteworthy role in the earlier conversations. Elliot, in a telling summary of that conversation, finds that the approaches to examining renewable development worldwide used two underlying distinctions. One approach dealt with the supply side through 'technology pushes' and the other dealt with the demand side with 'market pulls' (2005, 219). In somewhat related findings, Owen argued that there were actually three overlapping perspectives on the obstacles for renewables: 1) the 'research, development, and deployment' perspective; 2) the 'market barrier's perspective; and 3) the market transformation perspective (2006, 632). Over time, however, the emphasis in the larger work shifted away from the more research and development (R&D) or technological perspective. For example, Elliot finds

that the problems that are harder to resolve than technology are the institutional implementation and social problems (2000, 261). Elliot then took this observation one step further and argued that, "The current financial, organizational, and institutional environment is not very well suited to [Renewable Energy Technology] acceptance: there is, arguably, something of a mis-match between the new technology and the existing support infrastructure," (2000: 262).

From this point, the literature began to shift away from the technological perspective. In a telling observation of the shifting foundations of renewable energy, Martinot et al. make note that, "Changing investment patterns make it more important to think about markets for renewable energy, rather than simply about the technologies themselves and their economic characteristics," (2002:310). In fact, Elliot, in moving beyond Martinot et al., argued, "The shift was only partly due to the successful emergence of viable technologies from the R&D phase…It was arguably much more a result of a political shift away from government intervention and on to the market led developments, with the emphasis being on achieving competitive success," (220). While this sort of emphasis is most prevalent in the UK and US, it makes sense that it can also be seen elsewhere.

Subsequent work placed a greater emphasis on market-based perspectives. There was, however, an apparent problem. As Owen notes, the conventional energy markets and their historical contexts can in and of themselves act as a hurdle for renewable energy development (2006, 632). While governments were increasingly hesitant to intervene and allowed the markets achieve competitive success on their own, there were other barriers creating dissonance in this process. As the market transformation literature

progressed, it became clear that the relationship between renewable markets and government intervention was of particular interest. For example, Volpi argued that, "… the 'first' barrier to greater renewable energy penetration is the lack of enabling policy and regulatory frameworks, which usually favor traditional forms of energy sources" (ibid, 88). In this way, and while attempting to operate in a context designed for substantially different forms of energy, renewable energies were generally left to fight for themselves.

The examination of the more laissez faire approach then led to discussions surrounding the self-directed liberalization and privatization of state-specific markets. This discussion was further complicated by the observation that pressures also came from outside sources such as International Financial Institutions (IFI). In fact, this was evident in the imposition of liberalization and privatization upon markets (Volpi, 89). Over the last 15 years, such reforms have dealt with primarily economic objectives (with little to no attention paid to environmental and social impacts), which gets more complicated when coupled with the fact that there has also been a reduction in incentives for renewable energies (Volpi, 89). Not only, then, does one see countries making this choice, but outside entities were also imposing this choice upon others.

As the dialogue grew, so too did the need to examine the perceived hesitancy toward enabling policies and regulatory frameworks. As seen earlier, the market environment was complicated by the existence of infrastructures that support conventional forms of energy. The market perspective then began to look at the relationship between infrastructures, enabling policies and regulatory frameworks, and renewable energy development. Volpi argued that the fact that more traditional forms of

energy still benefit from massive subsidies including more direct forms like tax reductions and R&D funds acted as barrier to renewable energy development (ibid, 89). While the prevalence of these sorts of subsidies is certainly decreasing, according to the UNDP, in 2000 they still amounted to around $150 billion (2000, and as seen in Volpi). This does not even take into account hidden environmental costs or other types of subsidies such as, "… obligations to purchase a certain form of energy, reduced electricity rates for large (usually industrial) users, infrastructural support and exemptions from risks or liabilities" (Volpi, 89).

Over time, a number of fields began to weigh in on the barriers to renewable energy development. Despite the shift away from the technological perspective to the market-based perspective, there was still the need for a more concrete understanding of exactly what those barriers were. Martinot et al., in a telling summary of this shift, found that a substantial amount of the market-oriented literature leaned toward end-use applications, projects, or countries, and that "a global overview has been missing" (ibid, 312). Martinot et al.'s immediate concern was more market-oriented approaches, but little had been done to evaluate the international barriers to renewable energy penetration more generally. The growing debates surrounding globalization, and the privatization and liberalization of markets internationally, however, ushered in a new era. At this point, it was clear that the market-based perspective was of particular interest and further exploration was necessary.

Gradually, two other conversations worthy of discussion began to surface. To this point, there were now a number of possible barriers on the table and the two separate conversations, referred to here as the 'kitchen sink' and the 'context-specific' strands,

then began to enter the discussion. For the first, questions surrounding the role that economics, society, and politics play in RED through market-oriented approaches or socioeconomic systems were still theoretically relevant. In the most characteristic summary of this strand, Volpi, in quoting a report for the Group of Eight from the Renewable Energy Task Force, argued that, "the barriers to renewable energy are not technological, but rather political, financial, educational and related infrastructure" (ibid, 88). However, arguing that the barriers are political, financial, educational, and related infrastructural is far too broad. This strand of the literature seemingly began to co-opt all of the potentially relevant barriers. They then threw them all into the discussion, along with the proverbial 'kitchen sink'.

To be sure, there are a number of possible factors that can influence RED. While one can argue that "the international barriers are economic, social, and political," most of these factors each combine in a context specific manner that ultimately tells the interested scholar little about the possibilities of international barriers. In arguing that the largest barrier is social, for example, it is clear that the relative complexity of social indicators and the context-specific nature of their influence shape a particular society's development of renewable energy. When looking at the international level, however, little commonality exists among all countries. As such, it offers little explanatory power at that level. The same can also be said of economic barriers. In many parts of the world, concerns over the economic realities of instituting new technologies and/or existing infrastructure can seem almost insurmountable barriers, but invoking economic barriers fails to describe why one advanced industrial country with an immeasurable economic

advantage suffers in some of the same ways as another country with far fewer means. Of the possible barriers, however, there is a need to examine the political more closely.

There is less clarity on the relevance of international political barriers. For example, the political factors, like the commonly used measures of democracy (civil rights, political liberties, etc.) provide little explanatory value for understanding RED. Further, this proposition is so vague that it opens doors for a number of other theoretically relevant political barriers. For example, as seen earlier, it makes sense that a political system's willingness to intervene in renewable energy markets through regulatory frameworks and enabling policies can explain the success of certain countries and may even be common internationally. Moreover, the 'kitchen sink' strand had clearly been built upon the earlier discussions, and it ultimately said little about the possibility of international barriers that couldn't be seen in the market-based perspectives.

Alongside the 'kitchen sink' approach was a growing dialogue about the complexities surrounding the barriers to renewable energy development. In a telling observation, Geller observes that:

> "A wide range of barriers limit the introduction and deployment of energy efficiency and renewable energy technologies throughout the world. The significance of the different barriers varies among sectors, institutions, and regions. Some of the barriers will shrink as energy efficiency and renewable energy technologies advance and gain market share, but others are likely to persist unless directly confronted through policy interventions. Taken as a whole, these barriers are inhibiting the transition to a more sustainable energy future," (2003:33).

From this, one can tease out two important observations. First, this makes it is clear that in the broader discussion a 'wide range' of barriers is still in play, and little has been done to fully analyze the significance of these earlier perspectives. Second, this also brings to light a growing dialogue about the relevant levels of analysis. While the analysis of the

international barriers to RED is clearly still relevant, it is also clear that certain aspects of the broader dialogue began to focus more intently upon regional and domestic levels.

Subsequently, a second perspective focusing on context-specific explanations began to develop in the literature. For example, Painuly finds that the barriers to renewable energy technology penetration include "cost-effectiveness, technical barriers, and market barriers such as inconsistent pricing structures, institutional, political and regulatory barriers, and social and environmental barriers" (2001, 75). Painuly's immediate concern, however, was what individual countries could do and his work proposes a framework for the identification and analysis of the barriers to renewable penetration at the state level (ibid, 77). In fact, there were others also calling for state level identification and analysis. For example, as Johansson et al. argue, "The potential of markets for renewable energy and the role played by the public sector depend on the specific conditions in each country and region" (2004, 26). In taking this one step further, Painuly argued that these barriers also vary across countries and technologies (2001, 74). Clearly, the evaluation of the barriers to renewable energy development at the state level was justified, and many of the works to date seem to take this to heart (see, for example, Komor).

Ultimately, however, this discussion said little about the possibility of international barriers. In following this strand further, one can expect that when looking at the levels of development separately, many of the barriers proposed in the literature begin to make more sense than they did at the international level. For example, it would make sense that economic indicators would be statistically significant for developing countries. In all reality, this might be so because when scholars talk about international

economic barriers, more generally, they are actually referring to developing countries. It makes intuitive sense that a lack of available start-up capital for RED acts as a barrier for the developing world, but it does not make sense when referring to developed nations who posses that capital. This may also be true for level of education. In terms of political factors, however, it seems reasonable to expect that they will matter, but that there are also a number of intervening variables which carry varying weight depending upon level of development and that much more research has to be done in this regard.

In summary, while the 'technology push' or 'research, development, and deployment' approaches to the barriers to renewable energy development were initially informative, as time progressed, other and possibly more significant barriers came to the forefront of the discussion. In many ways, it seems as though even if these technologies were perfected at this point, that the institutional, market, and industrial contexts within in which they operate would still provide challenges. For now, it is also clear that both the kitchen sink and context-specific perspectives offer little explanatory value for an evaluation of the international barriers to renewable energy development. However, there is something still relevant within the market perspective. This literature indicates the relationship between interventionism and renewable energy development may hold the key to understanding the international barriers to renewable energy development.

Theoretical Development:

The development of the literature surrounding the barriers to renewable energy is instructive. While there were a number of potential barriers available for any scholar of the subject, a general overall lack of RED does indicate there are still significant

international barriers to RED. Further, while the technological perspective, the 'kitchen sink' and the context perspective strands are informative, the conversation surrounding the market perspectives is clearly the most relevant for a systematic international analysis. This section will start with an example and move on to outlining the most important aspects of this conversation. The paper then argues that the most relevant barriers to renewable energy development are enabling policies and regulatory frameworks. This work also suggests that such barriers are best approximated by analyzing the level of state interventionism, and hypothesizes that the relationship between renewable energy development and state level interventionism is curvilinear.

The case of the United States provides an excellent illustration of the forces at play. It is clear from the literature review that the U.S. has been largely unwilling to intervene in renewable energy markets. This unwillingness, largely the result of a general lack of enabling policies and regulatory frameworks on the part of renewable energy, has acted as a significant barrier. Admittedly, the relationship is complicated by the fact that the markets of more traditional forms of energy enjoy governmental support in the form of enabling policies and regulatory frameworks early on. While one market is expected to achieve success in the free market, interventions in another create an uneven playing field. In many ways, this uneven playing field also stands in the way of the success of renewable energy markets. However, it is that very lack of market intervention in the form of enabling policies and regulatory frameworks that is argued to explain the lack of RED in the U.S. Moreover, because of a number of other factors such as the spread neoliberal economic policies internationally, it seems reasonable to think that this may also be common internationally.

The inherent problem, then, is that traditional energy benefits from a long and prosperous history of government intervention, whereas renewable energy development, by many accounts argued to be better for economic development and both environmental and human welfare, did not experience such government support. While this paper is not about taking a side in this debate, it seems that it offers avenues for more successful investment in renewable energy. First, if government intervention on the part of conventional energy has created healthy markets, the intervention on the part of renewables can be justified. There is a large body of work advocating specific sorts of policies, regulatory frameworks, and subsidies for renewable energy development. This is a contentious area with a number of potential benefits and costs. Subsidies, in particular, can be a thorny issue. As Martinot et al. show in a telling summary,

> "Lessons suggested by experience are that: (a) subsidies are unlikely to lead to sustainable markets unless they explicitly create conditions whereby they are no longer needed (i.e. smart subsidies); (b) subsidies can undermine private investments and business in new markets and should be applied with attention to private-sector conditions in a particular market; (c) subsidies can be used effectively to build up initial market volume, local expertise, user awareness, appropriate technology adaptation, quality standards, and entrepreneurial activities; (d) subsidies are more effective when tied to operating performance rather than investment; and (e) continuing subsidies may always be needed for poorer segments of the population," (2002:332).

Second, if renewables are expected to achieve competitive successes through more market-led developments, then the regulatory frameworks, enabling policies, and related subsidies that favor conventional energy should be removed. In fact, the G8 Renewable Energy Task Force is sympathetic to this cause and argue that, the "removal of these subsidies would reduce electricity use, encourage equal treatment of renewable vis-à-vis conventional energies, and increase their deployment," (2001: 30). While this argument is quite agreeable to laissez faire economists, it is not as simple as it seems. Conventional energy companies are extremely wealthy and powerful, and the removal of

this sort of infrastructure, in most countries, is a difficult political process. Indeed, the powers that favor their elimination are dwarfed by political constraints and years of institutionalization.

Therefore, the relationship between the enabling policies and regulatory frameworks and RED deserves more attention. It seems that the degree of state intervention into energy markets through enabling policies and regulatory frameworks could be a common barrier at the international level. It appears that the most successful states are the states that have intervened on the part of renewable energy markets.

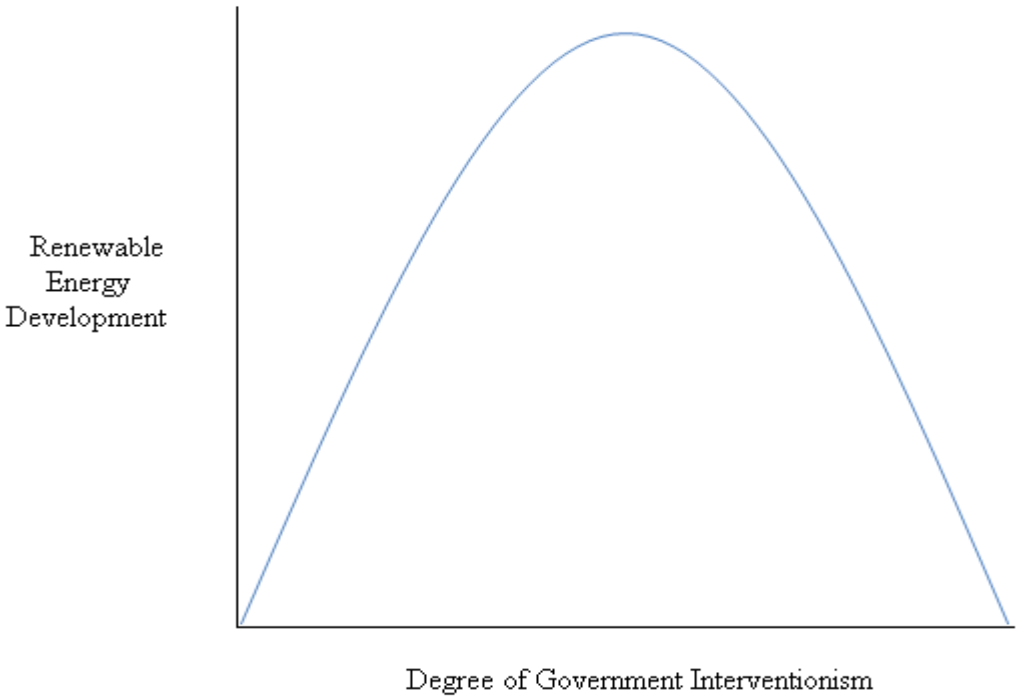
However, there are also countries with strongly interventionist policies but still struggle with RED. Fortunately, the developmental discourse sheds light on these cases. From this discourse one can see that there were two early perspectives of market interventionism for the developing world. According to LaPorta et al., the first was an optimistic developmental view in which economic growth focused on the necessity of financial development and advocated that governments own strategic economic sectors (2000, 3). The second was a view that argued that the control of financial institutions by governments "politicizes resource allocation for the sake of getting votes or bribes for office holders, softens budget constraints, and lowers economic efficiency" (ibid, 4). While it seems that the first was embraced by a number of developing countries, LaPorta et al. found that over time what actually happens falls more in line with the second or more 'political' theories of the effects of firm ownership by governments. What this means is that the embrace of this first developmental view by a number of countries, evident in control of those economic sectors, ended up doing much less than anticipated.

The above findings indicate that too much interventionism, seen in high levels of government control over financial institutions and other strategic economic sectors, actually weakens the economic development of these countries. While the particulars of these findings, the objections, and their validity are beyond the scope of this research (and are admittedly matters of debate among economists), few would disagree that many of these countries did not benefit from strong interventionism (if only evident by the fact that most are still 'developing' decades later).

An example illustrates this dynamic. Countries such Albania or Sierra Leone exhibit high levels of interventionism but relatively low levels of RED. The developmental discourse illustrates why one would see this discrepancy. Albania and Sierra Leone's specific forms of interventionism did not adopt the appropriate path to development identified by LaPorta et al. The key factor is an interventionism in the market through enabling policies and regulatory frameworks. In these two cases, the interventionism was too extensive and the complete control of economic institutions by these governments was a step too far. In fact, both of these particular examples are still struggling with development, which indicates that they fall in line with the expectations that too much interventionism has deleterious effects.

This paper therefore expects that the relationship between interventionism and RED successes is curvilinear. Following the above logic, it is expected that success in RED is difficult at either end of the interventionist spectrum. The figure below illustrates the central expectation developed in this paper.

Figure 1: Hypothesized Curvilinear Relationship



The paper thus expects that moderate levels of government intervention are most likely to lead to greater levels of RED. From this, this work hypothesizes:

> **Hypothesis 1**: The relationship between government interventionism and renewable energy development is curvilinear.

The illustrative examples show that it is not the enabling policies and regulatory frameworks which are to blame, but, rather, a particular prescription for economic development. In this light, there even seems to be a difference between interventions intended to harness market forces and those that take complete control of financial institutions.

There can be a number of different influences at play in any market scenario. Not only does the level of interventionism matter, but the amount of external influence can also shape a country's approach to the market. Structural adjustment loans by the World

Bank ushered in trade liberalization through the 1980's and 1990's (see Wade, 1993). While the results of these policies may ostensibly fall in line with the argument at hand, it is worth noting that a developing country's market perspective can also be shaped by outside sources. Related to this point, there are a number of domestic factors that come into play. The shape, size, and strength of a great variety of possible domestic influences can drastically shape a market perspective and/or the policy and regulatory options available to the relevant actor(s). However, the variety of influences and factors are intervening variables, and are beyond the scope of this project. This research focuses on whether interventionism affects RED, and not what shapes that specific form of interventionism.

What, then, does this suggest for the argument developed here? Level of development matters. Further, the scale of interventionism and type and strength of institution matter. Both domestic and international forces are also relevant. The same can be said for additional economic, political, and social factors. This argument, however, does not purport to understand how all of these other variables would matter. Simply listing the potential factors that matter does little to help scholars understand whether or not there are actually any international barriers to RED. The argument expects that the largest common barrier to RED will be a lack of enabling policies and regulatory frameworks. Anticipating a curvilinear relationship, the highest levels of RED are expected to be found in countries with moderate levels of interventionism.

To conclude, while research should still evaluate how Volpi's barriers stand in the way of realizing RED potential for individual countries, that literature offers little on cross-nationally relevant factors. A shift toward a better understanding of the enabling

policies and regulatory frameworks for renewable energy development at both the state and international levels will hopefully provide insight into renewable energy development and possibly suggest avenues for future research.

Causal Implications:

It is important to note that the causal implications coming from this analysis are limited. For instance, there are a number of possible intervening variables between enabling policies and regulatory frameworks and actual RED investment. However, there are also methodological reasons for not including these intervening variables. This analysis is theoretically-motivated and "data mining" is unjust. Further, as King, Koehane, and Verba illustrate, "…in general, we should not control for an explanatory variable that is in part a consequence of our key explanatory variable" (1994, 174). Therefore, this does not weaken the proposition that enabling policies and regulatory frameworks deserve more attention but suggests that there are a number of factors at play which can ultimately shape RED outcomes that are beyond the scope of this work. The relationship between RED and these frameworks nevertheless deserves more attention. Of the links suggested in the literature, enabling policies and frameworks also appear to be the most relevant barrier to RED. However, there certainly is a need for better specification in the future.

In addition, several assumptions drive this work. First, this paper assumes, for the sake of analysis, that there is a relationship between enabling policies and government intervention. Admittedly, there are a number of different types of policies and forms of intervention. This paper assumes that most of these policies happen in the form of

government interventions in the market. Arguably, this is also true of *ex post facto* laissez faire policies. Removing the barriers to trade are, in effect, interventions in the market, but are not considered in this analysis. Similarly, this paper assumes that by gaining insight into the relationship between a government's disposition to interventionism and RED, one also learns about the relationship between enabling policies and regulatory frameworks and RED. There are certainly important differences between enabling policies and regulatory frameworks specifically targeted at increasing RED and overall government intervention. Yet the purpose of this work is to take an initial empirical look at the possible barriers to RED and leaves more precise specifications to future work.

This paper is also about the broader institutional disposition to RED. Even if there were specific measures for Renewable Energy Policy, there may still be problems. The range of potential policies and the great regularity with which some governments pass policies that have little practical value, however, says little about a country's general disposition. A country predisposed to a laissez-faire approach may pass a number of policies removing barriers to the market. It is hard to quantify this predisposition. In contrast, a relationship between RED and a broader institutional disposition, as captured by the level of government intervention, gives researchers more to work with. Unlike a more specific measure, focusing on overall government intervention allows one to see at what level a laissez faire approach is able to succeed or fail. For the task at hand, it is also assumed that a measure of interventionism is sufficient for the identification of this potential barrier.

These theoretical insights inevitably lead to one immediate practical problem that must be discussed: the need for an adequate measure of Government Ownership of Enterprise (GOE). The problem with this sort of measure is that it limits the causal statements available to the researcher (see, for example, Wacziarg 2002, 909). GOE is unable to differentiate between the drivers of policy and anything about the endogeneity/exogeneity of that policy. Because of the difficulty specifying both the drivers of and internal/external influences upon a policy's success, the certainty with which a researcher can determine cause is limited. At the core of this work, however, is the general (and rarely random) disposition of a government to achieve a particular goal.

In fact, it is readily accepted that the endogenous selection of policies can guide them in a number of ways. There are a number of unobservable factors that can weigh in upon a policy's success and Rodrik identifies three: 1) the honesty of the government, 2) the extent of market imperfections, and 3) the capacity of the government to intervene effectively (2005, 5). The problem, in these cases, is that it is difficult to identify whether the government is acting in the public's interest. There is no way to tell whether the interests are private or public. Fortunately, this particular analysis is neither about the effectiveness of specific policies nor about the motives of governments.

What the paper is attempting to measure is whether there is a relationship between RED and intervention. While the hypothesis is that the relationship is curvilinear, there is no causal distinction about the drivers of policy. Generally, it is intuitive that the successes of RED will be limited at either end of the interventionist perspective. Even if a specific measure of GOE for renewables (GOE-R) were available, the causal statements about the effectiveness of this form of ownership are still limited. This is true because

the GOE-R would be a systematic response to market failures. As Rodrik illustrates, in these cases, there is no indication as to which of the potential drivers of policy is actually influencing outcomes (2005, 3). While this work does employ the logic of these theories to build its hypothesis, it does not need to make this distinction. In fact, this work is also taking into account those countries for which the policy response has been everything but a systematic response to market failures. As seen in the neoliberal examples, the responses to many of the problems has been a hands-off approach.

In addressing the barriers to renewable energy development, there are a number of difficulties in empirically evaluating the relationship between the enabling policies and regulatory frameworks in question, and RED. However, GOE provides the best measure to date. This project is also able to avoid some of the pitfalls traditionally associated with regressing growth with ownership of enterprise. In the future, further specification is undoubtedly necessary. For the purposes of this work, however, the variable is sufficient to assess whether more research along these lines is even necessary.

Research Design:

This paper has identified a number of possible barriers to Renewable Energy Development internationally. One of these proposed barriers, enabling policies and regulatory frameworks is argued to be the key explanatory factor in the argument developed here. This project conducts two quantitative analyses to analyze whether the argument is supported empirically. The unit of analysis for this study is the state, meaning that data are collected at the state level. This project evaluates the proposed

barriers in a longitudinal, cross-national study. The analysis employs data from 115 countries and covers the period from 1990-2006.

Dependent Variable:

The dependent variable for the analyses is renewable energy development. Volpi provides a definition of renewable energy: "'Renewable energy' commonly refers both to traditional biomass (firewood, animal wastes an crop residues burned in stoves) and modern technologies based on solar, wind, biomass, geothermal, small hydropower, wave and sea flow," (ibid, 84). This paper does not take large-scale hydro into account, which is also dismissed by much of the literature, including Volpi and Martinot et al., because of its environmental consequences and/or its relative maturity. Hydroelectric power has been around for quite some time (the Hoover Dam, for example, being completed in 1936) and the policies surrounding this form of renewable energy do not apply to this theoretical development. Because of its long history, large-scale hydro electric power benefits from some of the same institutionalization as many of the other more traditional forms of energy. The logic that holds for other forms of renewable energy does not apply, and it was not included.

The dependent variable for these analyses, then, is renewable energy production at the state level. As seen in previous arguments, land mass and resource allocation play differing roles in the development of renewable energies. For example, areas with geothermal fluid are more likely to develop geothermal energy. This project, however, is not about specific resources but rather examines what hinders a state from developing renewable energy more broadly. The measurement of renewable resources takes both traditional and modern forms of renewable energy into account. These data are taken

from the International Energy Annual of the Energy Information Administration of the U.S. Government.[1] The raw numbers of renewable production, however, do not take into account a variety of theoretically important insights, such as large fossil fuel reserves, and an index is created to find the best measure of renewable energy development.

The index of renewable energy development has three major components. Renewable energy production, total energy production, and total energy consumption are all important factors in moving beyond the potential pitfalls of raw numbers. In order to create the first component, the data for renewable energy are converted into quadrillion British Thermal Units (BTU's), the standard of measurement for the second two components. The index starts by calculating renewable energy production as a percentage of total energy production. This is important because a better picture of renewable energy as a part of the larger portfolio helps to alleviate concerns of land mass and resource allocation. The index then finds renewable energy production as percentage of total energy consumption. While renewable energy consumption is important, its measurement does not exist. However, it is unlikely that countries would export a significant amount of renewable energy. Solar energy, for example, cannot be exported in the way that oil can. It therefore makes sense for countries to consume renewables and export more tangible forms of energy, like coal and oil. Since both averages are conceptually important, they are averaged to create the index. The index ranges from 0 to 18.8%. High values, however, are far from common and the mean score on the index is around 0.8%.[2]

[1] International Energy Annual of the Energy Information Administration: http://www.eia.doe.gov/emeu/iea/contents.html

[2] It is important to clarify from the start that the data for the D.V. show a problematic distribution, skew, and kurtosis (Skew is 4.17 and Kurtosis is 29.4). Because the D.V. is a percentage between 0 and 1,

To illustrate cross-national variation in RED, the table below presents the 10 countries with highest RED levels in 2006.

Table 1: 10 countries with highest RED levels in 2006

Rank	Country	Renewable Energy Index	Total Renewables Produced (Quads)	Total Energy Produced (Quads)	Total Energy Consumed (Quads)
1	Benin	17.2044	0.000003	0.000010	0.039000
2	Luxembourg	10.3536	0.000549	0.002688	0.201213
3	Nicaragua	7.9487	0.001430	0.010290	0.071348
4	Ireland	7.2052	0.005674	0.041709	0.704358
5	Belize	6.5554	0.000224	0.006483	0.016144
6	Jamaica	6.5243	0.000345	0.002684	0.163680
7	Portugal	5.9633	0.016292	0.156298	1.084137
8	Iceland	5.9431	0.008534	0.124157	0.170241
9	Philippines	4.8431	0.033927	0.483465	1.271261
10	Kenya	4.7030	0.003958	0.053181	0.201551

Independent Variables:

The key independent variable for the analyses is the enabling policies and regulatory frameworks that have been identified as the most promising avenue for research. There are important connections between these policies and frameworks and government intervention in the market. The specific interest of this project is the relationship between market interventionism and RED. Unfortunately, existing measures of market interventionism suffer from a number of problems. This study briefly examines existing indicators in order to identify the best possible measure for this work.

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transformations do not normalize the data. This analysis tried the series of log transformations (natural log and log(10)), square root, inverse and arc-sine transformations, and the Box-Cox method. In the end, none of these transformations worked, and the remainder employs Robust Standard Estimates to compensate for the irregularity.

The most frequently used measure of market interventionism is the share of government investment in the private sector as a percentage of GDP. While sufficient for some studies, it can be fairly inaccurate when analyzing interventionism globally. For example, Knowles and Garces-Ozanne note that high-performing Asian economies have a low level of government spending and taxation, yet higher levels of interventionism than other industrialized countries (2003, 451). In fact, Knowles and Garces-Ozanne's central argument is that, "government spending is a poor proxy for government intervention more generally because in many countries around the world intervention is high even though government spending is low," (ibid, 457). Government investment in the private sector as a percentage of GDP, then, is not a satisfactory measure for a study including many states.

While some have attempted to rectify this problem by using indexes of market interventionism, such measures suffer from other problems. The same study argues that, "including all of [the components] in one index makes it impossible to isolate the effect of different types of intervention on economic growth," (ibid, 455).

Knowles and Garces-Ozanne then evaluate three different measures of intervention and find that two of them, the degree of red tape present and the extent of government ownership, can be used as proxies for regulation of the economy (470). Unfortunately, data on government red tape are sparse and available only for a small number of cases. The measure, borrowed from Morrow, is an index based upon standard questionnaires by *Business International*'s (BI) correspondents in 70 countries from 1980-83 (Mauro 1995, 682). The time frame is insufficient for this project and the survey of 70 countries with BI correspondents would severely limit the number of cases.

The extent of government ownership is the final measure considered for this project. Government Ownership of Enterprise (GOE), the indicator that Knowles and Garces-Ozanne use for their work, comes from Gwartney et al.'s *Economic Freedom of the World.*[3] While data for earlier years come from a variety of sources, most of the recent data come exclusively from the Government Financial Statistics database. However, the new data do not cover much of the developed world, where data are still collected from a number of sources and show some puzzling patterns. Given the weaknesses of alternative indicators, it is nevertheless the most appropriate and complete proxy to date. GOE data, calculated as gross fixed capital formation (public sector) as a share of gross fixed capital formation (total), are used to measure government regulation. The data for the 1990-2000 period are collected only in 5 year increments and, therefore, the values are carried forward for the years in between. Since 2000, data have been collected on a yearly basis. The data range from just under 2% ownership of enterprise to 100%.

Control Variables:

Drawing onVolpi's work on the subject, this paper adds four control variables. As noted earlier, these proposed variables are political, economic, educational, and related infrastructural factors. A number of general indicators are available for the first three variables and the project employs measures that are commonly used in the international relations literature. Related infrastructure, however, is a much more elusive concept. Fortunately, Volpi's conceptualization includes two characteristics seen elsewhere in the literature. The first, enabling policies and regulatory frameworks, is the

[3] Fraser Institute: http://www.freetheworld.com/datasets_efw.html

I.V. of interest for this project. The second characteristic focuses upon outside funding, such as International Financial Institution (IFI) incentives, which presents a feasible avenue for measurement. For each of these control variables, the literature logically implies that the expected relationship will be significant, positive, and of at least moderate strength. Due to the hemispheric proliferation of neoliberal market philosophies and a number of counter examples, however, this paper expects less.

For the political factors affecting RED, a commonly used indicator is a measure for democracy. The Polity 2 measure used by the Polity IV Project seems most appropriate for this study. It indicates a country's democracy level raging from -10 to +10, ranging from most authoritarian to most democratic. [4] Data are available for most of the cases and come directly from the project.[5] The literature, again, expects that the relationship will be significant, positive, and of moderate strength. As seen in the case of the United States, however, some democracies are struggling with RED. Clearly, the literature is grounded in more observations than one example can contest. Therefore, this work allows for the relationship to be significant. However, the paper also expects that the literature overstates the strength of the relationship between Democracy and REI. Some of the most democratic countries, like the U.S. and the U.K., still struggle. Therefore, the strength of the relationship is logically questionable.

The second control variable accounts for economic factors. This work employs the Purchasing Power Parity (PPP) of per capita GNI. According to the United Nations

[4] The original Polity indicator contained measures for authority that do not make sense for a longitudinal analysis. In 2002, Marshall and Jaggers set about fixing the problem by smoothing out minor fluctuations in these data. For the Polity 2 measure, they point out that, "… the data codes general institutionalized authority traits that characterize a distinct polity (a polity distinguished by major regime changes at both its inception and its termination); annual case codes for all years between polity inception and termination are generally the same," (2002, 14). Polity IV: http://www.cidcm.umd.edu/inscr/polity/index.htm

[5] Polity IV: http://www.cidcm.umd.edu/inscr/polity/index.htm

Development Program (UNDP), "PPP (Purchasing Power Parity) rates of exchange allow this [measure] to take account of price differences between countries. GNI per capita (PPP US$) accounts for price differences between countries and therefore better reflects people's living standards," (UNDP, 2007). The data are available for a majority of the cases and come from the online WDI database of the World Bank.[6]

As with democracy, it is not likely that economic factors will have a strong effect on RED. If economics factors were a significant barrier, the most advanced industrial countries would have highest RED levels because they have the most available start-up capital. Since this is frequently not the case, the paper expects less. Interestingly, economics can also act as a proxy for the 'Technology' arguments seen earlier.[7] If technology were a barrier, the relationship would be significant, positive, and of moderate strength. There are at least two significant strands of the literature draw attention to this relationship. Clearly, there are reasons to believe that the relationship will be significant. This paper, however, expects that each strand of the literature overstates the role of this variable. It expects a weak relationship between PPP and RED.

Third, literacy rates are used as the measure for educational factors. While there are more refined measures of education, such as the Education Index of the UNDP, they are not available for every year of the time period in question. Data for literacy rates are available for a large set of countries but only for a small number of years. Since literacy rates are unlikely to change dramatically over time and to minimize a loss in the number

[6] World Bank-World Development Indicators online: http://ddp-ext.worldbank.org/ext/DDPQQ/member.do?method=getMembers&userid=1&queryId=6

[7] Theoretically central to many of the 'Technology' discussions is the cost of these technologies. Many of these works imply that as these technologies reach maturity, they will become cheaper and increasingly prevalent. An economic indicator can therefore, albeit weakly, indicate whether cost appears to be an issue.

of cases, the data are held constant. The data are taken from the United Nations Educational, Scientific and Cultural Organization (UNESCO) and represent the percentage of the country's population that is literate.[8]

Expectations for this variable are similar to the democracy measure. There are states with very high levels of education but little investment in RED. This suggests that Education makes little sense as a barrier to renewables. Further, education does not seem to be grounded in the same ways that Democracy or Economics are. It is expected that the relationship between REI and Education will be insignificant.

Finally, the variable for related infrastructure, measured here as outside sources of funding, comes from the World Development Indicators (WDI) of the World Bank.[9] Volpi's discussion of the barriers to renewable energy development mentions how IFI incentives, subsidies, and available start-up finance can each act as barriers to renewable energy development. While there is no variable that captures these perfectly, the World Bank provides a variable measuring Official Development Assistance (ODA) and Official Aid (in current US$). According to the World Bank, the ODA data contain, "the flows of official and private financial resources from the members of the Development Assistance Committee (DAC) of the Organisation for Economic Co-operation and Development (OECD) to developing Economies…" (WDI 2007). Because the data for Direct Foreign Investment also come from the DAC, they are equally justifiable. However, the WDI take ODA data and add 'official aid,' which includes transactions for which the goal is not development (ibid, 2007). Because the incentives and subsidies for renewable energy can come from transactions with goals other than development, and

[8]UNESCO: http://data.un.org/Browse.aspx?d=UNESCO. Where necessary, estimates came from UNESCO's former literacy projection model (July 2002 Assessment).
[9] World Bank-World Development Indicators online: ibid.

because the availability of start-up finance more generally is important for this variable, this is the best indicator of related infrastructure.

The variable is attributed a distinct role in the literature. Volpi suggests that the availability of start-up capital is a significant barrier to RED. It is expected that larger amounts of aid increase the potential for developing renewable energy portfolios. The argument is reasonable and finds little opposition in the literature. This paper expects that the coefficient for this variable will be significant and positive. However, in maintaining theoretical consistency with the preceding expectations, this variable is not expected to carry moderate strength. The descriptive statistics for all variables are presented in Table 2.

Table 2: Descriptive Statistics for the Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
REI	1707	0.8	2.3	0	18.8
Curvilinear Intervention	1707	1437.331	1662.089	4	10000
Intervention	1707	33.137	18.424	2	100
Democracy	1638	3.705	6.244	-10	10
Economics	1661	8673.365	10185.780	200	60870
Education	1707	77.249	22.281	9.391	99.441
Aid	1608	359000000	556000000	-959000000	6440000000

Analysis 1:

The first analysis presents of a test of the theoretical argument and evaluates barriers for RED emphasized in the existing literature. Using a multiple regression model, the analysis tests whether the most significant international barrier to renewable energy development is enabling policies and regulatory frameworks. Because investment in RED varies across different countries and changes over time, a time-series cross-sectional analysis is justified. As Babbie argues, often in social research there are

situations when several independent variables simultaneously affect the dependent variable, and, "multiple regression analysis provides a means of analyzing such situations" (2006, 458). This analysis also investigates earlier work in the field (particularly that of Volpi) to see whether the political, economic, educational, and/or related infrastructural variables are significant. The proposed analysis will help to illuminate which of the barriers are relevant for future work.

Results:

This section examines the results of the initial tests, investigating the proposed curvilinear relationship between government intervention and RED. After completing the requisite assumptions tests and regression diagnostics for the proposed model, this work uses Bayesian model selection (for the regression diagnostics see Appendix A). While the model in question is theoretically grounded, the relative dispersion of the literature and "kitchen sink" nature of the control variables lead to a number of questions surrounding specification. Because the sample size is large enough, Bayesian Information Criteria are the most appropriate way to analyze the models in question.

The first model, the specified curvilinear model, employs REI as the dependent variable, the intervention variable, intervention squared (the curvilinear indicator) and the control variables. The second model is a linear version of the first and excludes the squared term. The third model follows the "Laundry list" approach and adds four new variables to Model 1, including variables for imports, exports, and regime durability. The table below shows the results for each model and presents the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC).

Table 3: Model Selection: Akaike Information Criterion and Bayesian Information Criterion

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
Model 1	1504	3980.244	4032.85	6	-8053.7	-8021.81
Model 2	1504	3980.244	4028.805	5	-8047.61	-8021.03
Model 3	1504	3980.244	4040.86	10	-8061.72	-8008.56

For interpretation of AIC and BIC, the best model is the one with the smallest score. The results indicate is the first model is the most appropriate. The remainder of the analyses will employ this model. The results of the model for Analysis 1 can be seen in Table 4. R-squared is 0.078, indicating that the model accounts for 7.8% of the variation in the dependent variable.

The most important result is the significance and strength of the coefficients for the key independent variables. The coefficient for the key independent variable, the variable estimating the curvilinear relationship, is significant at the .01 level, and carries a

Table 4: Results of Analysis 1

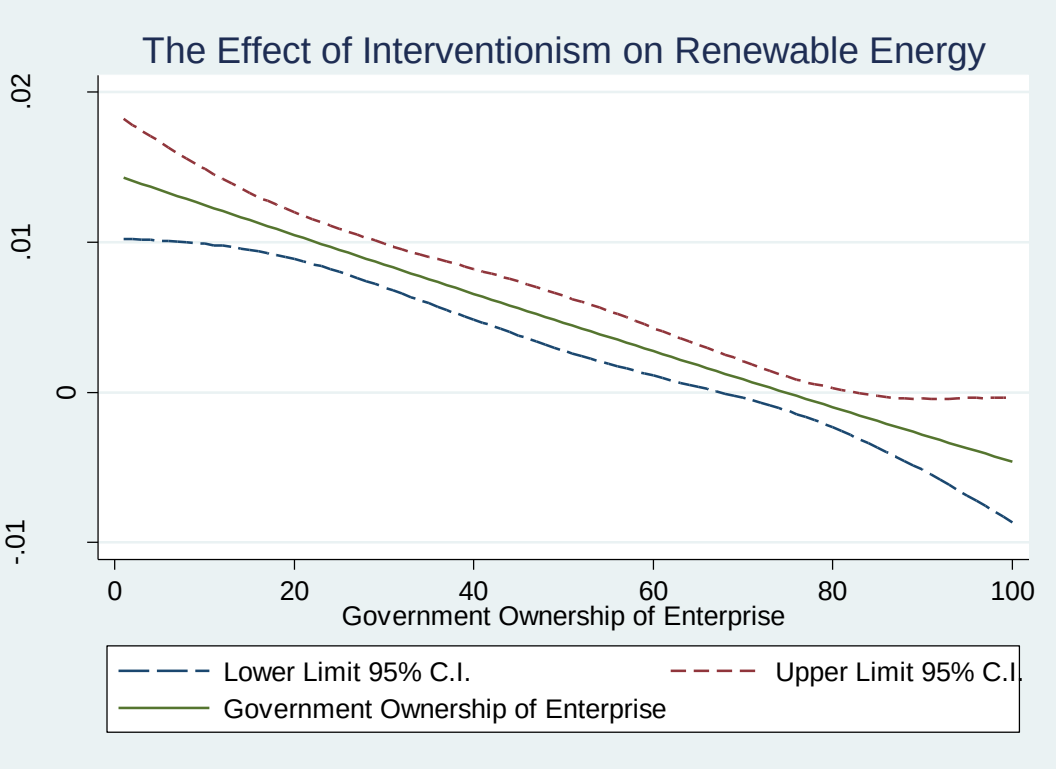
Number of obs =	**1504**
F(5, 1497) =	.
Prob > F =	.
R-squared =	0.068
Root MSE =	0.017

REI	Coef.	Robust Std. Err.	t	P>t	Beta
Curvilinear Intervention	0.00000	0.00000	3.480	0.001	0.271
Intervention	-0.00043	0.00009	-4.940	0.000	-0.473
Democracy	0.00039	0.00006	6.900	0.000	0.141
Economics	-0.00000	0.00000	-3.510	0.000	-0.084
Education	-0.00006	0.00003	-2.160	0.031	-0.080
Aid	0.00000	0.00000	1.290	0.196	0.022
_cons	0.02030	0.00341	5.950	0.000	.

beta weight of .27. This relationship is inconsistent with the proposed curvilinear relationship, and is also of medium strength. Figure 2 shows the effect of interventionism on renewable energy along with the upper and lower limits of the 95% confidence interval (C.I.). This falls completely out of line with expectations and will be discussed more in detail in the discussion section.

All but one of the control variables are significant beyond the .05 level. Further, all but two of the variables fall in line with the theoretical expectations that guided the model. The results show that each of these variables also depart from the expectations seen in the literature. For example, none of the control variables exhibited anything but

Figure 2: The Effect of Interventionism on Renewable Energy



weak relationships to REI. From there, the results are not uniform, and it is best to discuss each variable in turn.

The strongest of the constants was Democracy, which was expectedly significant. The relationship positive and weak (a beta weight of .14). This also falls in line with expectations. Interestingly, while the literature presumably expects that each of the relationships will be positive, Democracy was the only variable with a positive coefficient.

Moving down in strength, the next significant variable is the economic indicator. With a beta weight of -.084, these results also fall in line with this paper's expectations. Looking back, it did not make theoretical sense that countries like the United States who do well on most economic indicators would struggle so much. As such, it did not seem to make sense that the barriers to RED were economic in the ways that had been suggested. These results show that, although the relationship is weak, there is a negative relationship between Economics and RED success. This is also a drastic departure from the literature, and will also be discussed further.

The next relationship exhibiting significance at the .031 level is the coefficient for the education indicator. The weight of this relationship is also weak, at -.08, and falls in line with expectations. Further, this indicator also indicates a polar change from the literature's expectation.

The only insignificant control variable is the variable for aid. This finding contradicts the expectations of both the literature and the theoretical development. Volpi suggests that one of the largest barriers to RED is the availability of start-up capital. The more development assistance and aid are available to a country, the more start-up capital is theoretically available. These results are counterintuitive since they indicate that Aid is

irrelevant as a barrier to RED. Possible reasons for this relationship will be discussed in the discussion section.

Taken together, the results give mixed signals for the theoretical expectations. The curvilinear relationship hypothesized in the theoretical section is supported empirically. However, it is opposite to the proposed relationship. In addition, all but one of the control variables are significant. That said, the results do not necessarily always fall in line with expectations. Their significance, however, says much about the presence of international barriers to renewable energy development. The most important relationship stemming from this analysis is a curvilinear relationship between GOE and RED. At a minimum, this finding indicates that more attention should be given to government intervention and its effect on RED. Among the control variables, results show a need to pay specific attention to each of the negative relationships. The results show that economics and education do not affect RED in the way proposed in the literature. In addition, the insignificance of the relationship between Aid and RED deserves more attention. While a more nuanced specification of aid for RED is necessary, the relationship presented here warrants a need to proceed with caution.

Analysis 2:

While the first analysis is appropriate for a number of reasons already put forward, it also makes sense that differing contexts, particularly level of development, can influence the production of renewable energies. The imperative for renewable energy development is also arguably more significant for developing countries. As Martinot et al. point out, while consuming only around 30% of the available commercial energy, developing countries house around 80% of the world's population (2002, 310).

As the world's population grows and developing countries develop, so will the demand for energy. To state this even more clearly, the UNDP observes that the energy perspective has given negligible attention to poverty, but that "… energy is central to the satisfaction of basic health and nutrition needs, and that energy services constitute a sizable share of total house expenditure in developing countries," (2000, and as seen in Volpi, 2005). Clearly, there is much at stake for the developing world when it comes to investing in renewable energy.

This recognition of the contextual differences between the levels of development has instigated much of the work on the subject. Whether for sustainable development, liberal economic, or institutionalist reasons, there have been a number of efforts to develop renewable energies in the developing world. However, several of the donor aid based programs designed for developing countries early on have been unsuccessful. As Geller puts it, "the World Bank and bilateral donors have at times been criticized for failing to build an infrastructure that is capable of marketing and supplying solar energy and other sources of renewable energy devices over the long run once a particular 'development project' ends," (84, see also Martinot et al. 2002, Mulugetta, Nhete and Jackson 2000). Admittedly, a noteworthy debate springs from this analysis and is the subject of great discussion. It is therefore worth exploring whether contextual indicators such as level of development affect RED.

The second part of this project therefore examines the proposed differences as a function of level of development. The preceding passage suggests that there are clear differences in the ways that groups of countries harness their renewable energy potentials. The literature also suggests that the path taken may depend upon the

country's level of development. For example, developed countries have a greater variety of RED mechanisms at their disposal than countries at the other end of the developmental spectrum. It is therefore justified to empirically evaluate how the variables employed in the first analysis play out at each level of development. The second analysis will evaluate whether the barriers in the first analysis appear to be different based upon level of development and which barriers appear to be significant at each level. Finally, and more specifically, it will evaluate whether donor aid is statistically significant. The second analysis thus adds empirical support to a number of contextually bound arguments.

Results:

Countries identified by the UNDP as very highly and highly developed were added together. The work then employed the same variables as the previous model for this group of countries. Immediately, however, there was a problem. The Curvilinear indicator was insignificant. The analysis then ran a linear model. A comparison of the results can be seen in Table 5. These results clearly differ from the first analysis. In this half of countries, the significance of the curvilinear indicator drops out entirely.

Each model also captured 21.5% of the variation in the D.V. While the difference is arguably negligible (the only difference being Interventionism), the linear model indicates that linear interventionism is still significant for this half. Therefore, the linear model was the most appropriate way to examine the barriers to RED at this level.[10] The relationship between GOE and REI is depicted in Figure 3.

Despite this departure, this model also exhibits a number of relationships consistent with the first analysis. The work developed no specific expectations for this

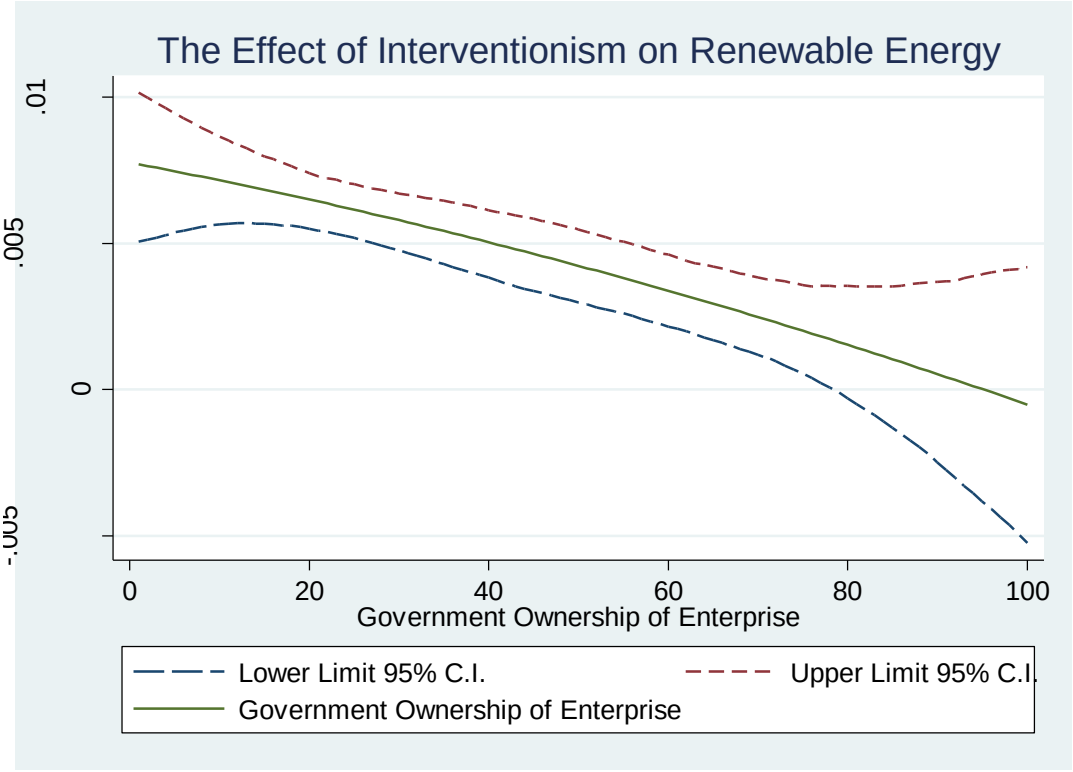
[10] This finding was confirmed by Bayesian Model selection.

Table 5: The Results of the Curvilinear and Linear Models for Developed States

VARIABLES	Curvilinear Model	Linear Model
Curvilinear Intervention	0.000	
	(0.000000855)	
Intervention	0.000	-7.77e-05***
	(0.0000781)	(0.000015)
Democracy	0.000	0.000
	(0.0000876)	(0.0000875)
Economics	4.90e-07***	4.90e-07***
	(0.0000000938)	(0.0000000938)
Education	0.000170***	0.000168***
	(0.0000506)	(0.0000498)
Aid	0.000	0.000
	0.000	0.000
Constant	-0.0157***	-0.0152***
	(0.00457)	(0.00412)
Observations	725.000	725.000
R-squared	0.215	0.215
	Robust standard errors in parentheses	
	*** p<0.01, ** p<0.05, * p<0.1	

division of development. Nonetheless, it is not necessary for this half to cover the entire range of observations that guide the theoretical development. For example, it is rather unsurprising that the significance of Democracy drops out entirely. There is no reason to expect this indicator to hold at this level. This makes sense because the examples leading the countervailing theoretical development are found in this half. That said, it is worth pointing out that there are still similarities between models.

Figure 3: The Effect of Interventionism on Renewable Energy



The most immediate similarity is that the Aid variable is still insignificant. Further, the education variable is still significant. Still of weak strength, the relationship between REI and Education becomes positive. Interestingly, this falls much more in line with the expectations of the literature. It does not even necessarily contradict the theoretical development, which expected that, if significant, the relationship would only be of weak strength.

The strongest finding for this half of the analysis, the Economic indicator, carries the largest beta weight at this level. In fact, it is significant, *positive*, and of moderate strength (significant beyond the .001 level the beta weight is .392). This finding is completely inconsistent with the first analysis and the results are puzzling. Logically, it does make sense that the relationship between RED and Economics is positive. This is

especially true for this half of the developmental spectrum. The more start-up capital a state has, the more likely it is that they will be able to develop a portfolio of renewable energy. Before discussing this point much further, however, it is important to see the results for less-developed countries.

The same variables were included in an analysis of countries identified as exhibiting medium and low levels of human development. Due to the results of the previous analysis, the work ran both the curvilinear and linear models examining the barriers to RED. These results show a direct and immediate departure from the model examining the top half. Most importantly, the curvilinear relationship is significant at this level. The results are shown in Table 6. The model captures 7.2% of the variation in the D.V. and the results show that the relationship between Intervention and REI is significant for both the curvilinear and linear indicators. What is surprising is that the model exhibits a different relationship than seen up to this point. This is best seen in Figure 4.

This finding raises some questions for the theoretical argument. The curvilinear hypothesis expected that too much intervention would ultimately hinder RED. It is puzzling that RED increases at the ends of the interventionist spectrum. Further, compared to the mean REI of 0.57% for developed states, the mean for this half is 0.93%.

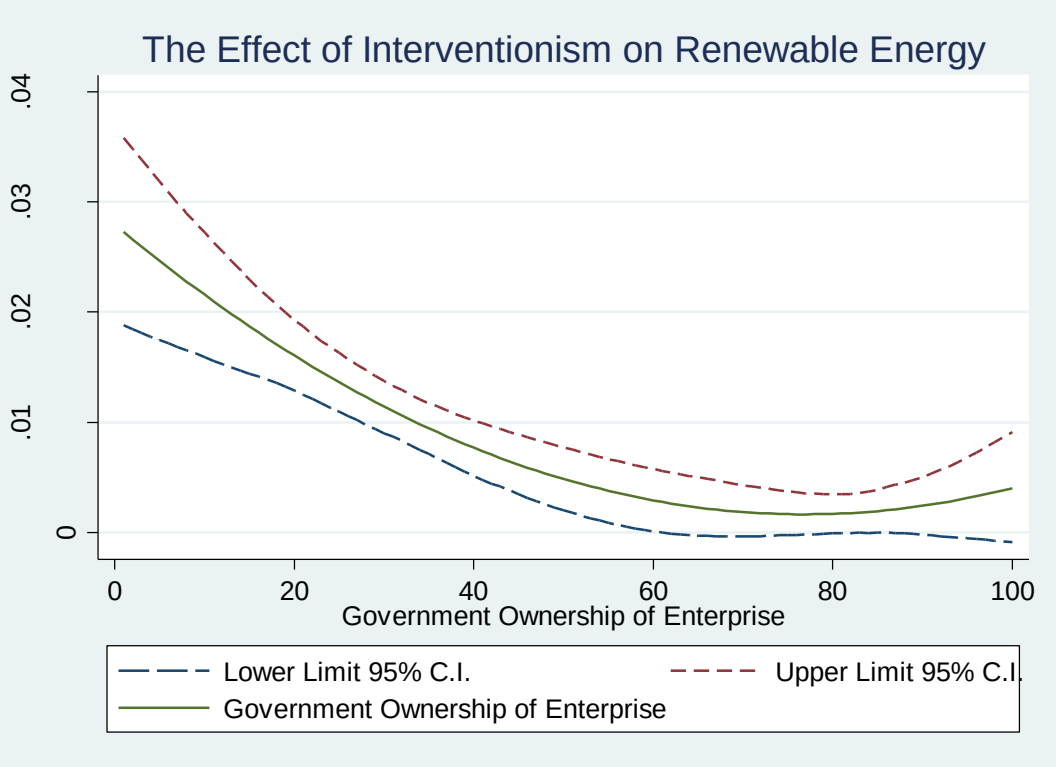
Table 6: The Results of the Curvilinear and Linear Models for Developing States

VARIABLES	Curvilinear Model	Linear Model
Curvilinear Interventionism	4.45e-06**	
	(0.00000175)	
Interventionism	-0.000684***	-0.000254***
	(0.000196)	(0.0000396)
Democracy	0.000536***	0.000531***
	(0.000117)	(0.000118)
Economics	0.000	1.05e-06*
	(0.000000626)	(0.000000611)
Education	0.000	0.000
	(0.0000385)	(0.000039)
Aid	-0*	-0**
	0	0
Constant	0.0255***	0.0170***
	(0.00559)	(0.00373)
Observations	844	844
R-squared	0.072	0.066
	Robust standard errors in parentheses	
	*** p<0.01, ** p<0.05, * p<0.1	

Before attempting to discuss these results, it is important to pay attention to the control variables.

The findings for the control variables are mostly opposite to those in the first half. Variables that were significant in the first, such as economics and education, are now insignificant. Those that were insignificant, Democracy and Aid, are significant in this model. When combined with the departures of the first half with the larger model, the

Figure 4: The Effect of Interventionism on Renewable Energy



change in results is unsurprising. However, the specific results do contribute a number of interesting findings.

Looking back, many of the proposed barriers were informed by an evaluation of the developing world. What is striking is that all but one of these barriers depart from the literature. Democracy is significant and positive for these levels. Looking back, it was also the strongest relationship of the control variables in the international analysis. Its relative strength does not meet the literature's expectations, but it is the closest these variables get to describing the barriers to RED.

The strangest departures from the developmentally informed literature are economics and education. The economic variable is no longer significant. The same is true for the educational indicator. Again, this is opposite to findings in the first half of the second analysis. In fact, the only variable that is consistent with the expectations that

guided the second analysis is Aid. It is only at this level that it becomes significant. Theoretically, more Aid would mean more available start-up capital. However, the relationship does all but confirm expectations because the coefficient is *negative* and the relationship is weak. Clearly there are a number of puzzling findings, and they will be discussed in greater detail in the discussion section.

Taken together, the second analysis highlights important differences from the first analysis. There clearly seem to be differences based upon level of development. However, most of these results stand in direct contrast to the expectations stemming from the literature. The only finding that fell completely outside of expectations was that of the hypothesized relationship. In every analysis, the results run counter to both a broader literature and to the theoretical development of this work. It is therefore important to briefly examine this relationship under an analytical light before discussing the findings.

Analysis 3:

What is it about the relationship between GOE and REI that is so peculiar? The answer to this question is beyond the scope of this project. However, there do seem to be multiple lines of evidence that point the researcher in the right direction. Looking back, there are number of areas of uncertainty surrounding enabling policies and regulatory frameworks. While theoretically grounded, there are a number of practical problems that are much more significant than expected.

First and foremost, as seen earlier, there is a problem of specification. The theoretical development hypothesizes that the relationship between enabling policies and regulatory frameworks is curvilinear. There are no specified variables for renewable enabling policies and regulatory frameworks. In operationalizing this variable, it was

necessary to assume that these policies and frameworks can be proxied as interventions. The work then employed the best possible measure of government interventionism which can be argued to be suspect. However, it is not yet necessary to reject either the hypothesized relationship or the analysis since problems could also lie in the GOE variable employed. If one can show that it is the GOE variable that is to blame, the larger theoretical development may remain intact.

This work was clear on the weaknesses of the GOE measure. The literature, however, suggests that it is the best proxy to date and it therefore makes sense to employ it. However, the variable is much more suspect than the literature suggests. In taking a closer look at the data, there are a number of problems. First and foremost, the data come from at least two different sources. This work did observe this from the start, but it appears more problematic than originally anticipated. Problems with the data were clear early on, and can be seen in Table 7. Data on GOE change dramatically between 2002 and 2003. In clarifying the problem, I e-mailed the creators of this dataset for

Table 7: Problematic Data

Year	Australia	Austria	Belgium	Denmark
1990	25.2	42.0	27.0	20.3
1995	21.5	42.0	27.0	24.9
2000	21.5	42.0	11.9	24.9
2001	21.5	42.0	14.9	24.9
2002	21.5	42.0	20.6	24.9
2003	8.6	5.4	8.7	8.1
2004	8.6	5.1	8.0	9.1
2005	8.9	5.4	8.5	8.6
2006	9.1	4.7	7.7	8.6

clarification. The creators made it clear that the project was in the process of switching data sources. The larger project, it was argued, had made an attempt at incorporating data from a single source as much as possible. They even provided a dataset with all of the data taken from a single source. Armed with the dataset and, again, the usage of the dataset in the larger literature, the analysis proceeded.

However, it is clear that the data are more problematic than anticipated. As an initial test, this analysis examined the international data for a four year period on either side of the apparent problem. The results are illustrative. Looking at the means from each period tells a peculiar story. In fact, the changes between these two periods for GOE are counterintuitive. While one would expect changes, it seems reasonable that they would be consistent across variables. In looking at the percentage of change in the means between periods, the results are seen in Table 9. Not only is the change in GOE twice that of the other variables, but it is also change in the opposite direction. This is

Table 9: Percentage Mean Change between 1999-2002 and 2003-2006

REI	2%
GOE	-4%
Democracy	1%
Economics	2%
Education	2%
Aid	1%

potentially problematic. There appear to be no actual changes at the international level that would explain such a result.

Even if one were to allow for drastic global changes of this nature, there are still problems. The data come from at least two different places. For some of these countries, the data come from a single source and are uniform. For other countries, there is no

telling exactly where the data come from. This would be more acceptable if the data from a single source and the more problematic data were evenly distributed. However, it is not. Looking at the UNDP HDI rankings, the countries represented by the data from a single source are remarkably uneven. The data representation can be seen in the following table.

Table 10: Percentage of Countries Represented in Data From a Single Source by Level of Development

Rank	Very High	High	Medium	Low
Countries Represented	8%	33%	51%	83%

Undoubtedly, this is far too uneven. The reliable data, the data from a single source, even represents 63% of the countries without renewables as compared to 45% of those with. This gap is far too great.

Ultimately, this suggests that however popular in the literature, the data for GOE is problematic when looking at the international level. The accurate data highly favors developing countries. As Australia, Austria, Belgium and Denmark illustrate, this may also strongly favor a negative relationship between REI and GOE.

Figure 5: GOE by Year for Examples of Problematic Data

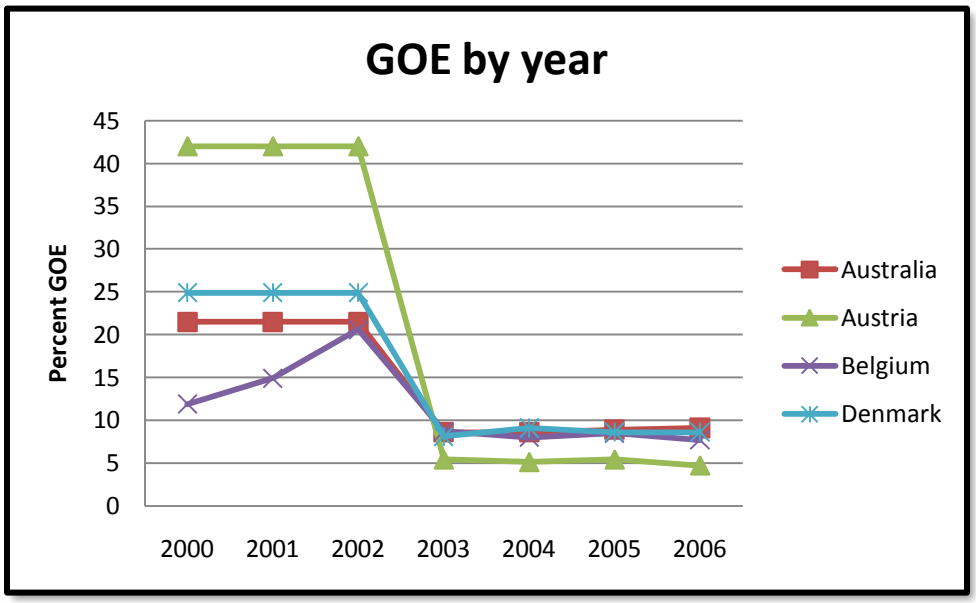
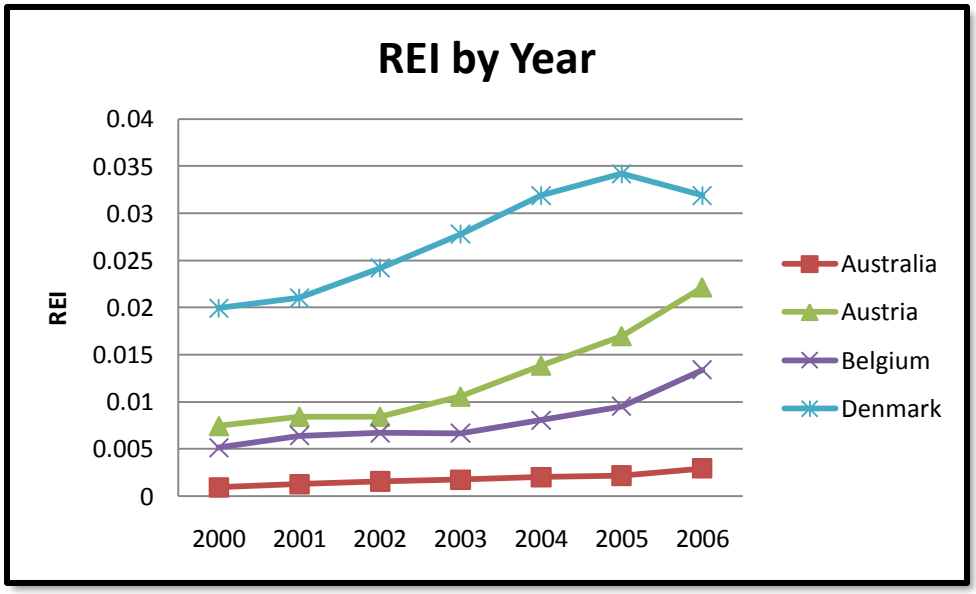


Figure 6: REI by Year for Examples of Problematic Data



These figures show how much the problematic data can influence the proposed relationship. The two sources certainly increase the strength of the negative relationship. Until the data are fixed, the data should be used with appropriate caution.

The lesson, for this work, is that the relationship between REI and GOE coming from Analysis One and Two is suspect. While they initially seemed to challenge the proposed hypothesis, the data unduly favor contradictory results for both Interventionism and Curvilinear Interventionism. The results, then, neither confirm nor refute the hypothesis. Until better data are specified and the empirical relationship is examined further, the hypothesis remains tenable.

Discussion:

The results of these analyses are mixed. Some of them fall directly line with expectations. Others are far from what was expected and deserve more attention. For obvious reasons, the results for both Interventionism and Curvilinear Interventionism will largely be left out of this analysis. Nonetheless, the findings surrounding the control variables are telling. This section will start by discussing the findings of each analysis and the expectations that had been developed for each. Where findings were unanticipated, the discussion will attempt to evaluate the logic and empirical reality of each finding to make sense of conflicting results. From there, this discussion will bring in outside work that may increase our understanding.

The first analysis largely followed expectations. It is important to make specific note of the fact that Bayesian Model selection confirms the choice of model. Not only does this help to validate the theoretical development to some degree, but it also confirms the inclinations of those that employed a kitchen sink strategy in approaching the barriers to renewable energy development. Within the confines of this study, the best model was the model that expected that the relationship between RED and Intervention was

curvilinear, and included the political, economic, educational, and related infrastructural indicators.

The results of the first analysis also help corroborate the theoretically driven expectations of this work. Starting with the strongest of the control variables, Democracy was significant, positive, and of weak strength. The literature would seem to suggest that this relationship should be stronger, but this work expected otherwise. What this suggests is that at the international level, the political constant has a steady, yet relatively weak effect upon RED. Peculiarly, this relationship was the only positive relationship at this level of analysis. While renewable energy may make theoretical sense for all sorts of political systems, it is those that are more democratic that tend to be doing better in general. That said, there are still questions as to how endogenous and/or exogenous political variables affect RED, and it is prudent to rely upon the common academic refrain, 'More research along these lines is necessary.'

The most counterintuitive result coming from the first analysis was that of the Economic variable. As discussed briefly, the apparent divergence of this variable from the literature causes some dissonance. Looking back, the same logic that informed the expectations about Democracy was also expected to hold for Economics. It makes little immediate sense why the direction of this variable would seem to stand in direct contrast. This also stands in direct contrast to the literature. Countries with higher PPP's are doing worse at developing renewable energy. This work expected a weak relationship, but this result is counterintuitive. The expectations were built upon the logic of countries that should be doing well, but were not. These expectations, however, would not have taken it this far. This also casts light upon the cost reliant technological discourse. It is

important, in this light, to examine how this plays out based upon level of development. Before doing so, however, there is one final control variable in need of discussion at this level.

The final variable significant internationally was Education. The result, a negative and weak relationship, shows that a country's level of education has little to do with REI. In these cases, although the indicator is significant, is has less to do with renewable development that the literature anticipates. This finding follows the expectations of this work, and falls in line with the economic findings. These results also fall contrary to those of Democracy, and it is to the second analysis that the discussion turns for clarification.

The second analysis, born out of the more 'context specific' strand of literature, started by dividing the world in half according to the UNDP's Human Development Rankings. Developed States were those countries identified by the UNPD as exhibiting "Very High" and "High" levels of human development, and Developing States were those identified with "Medium" and "Low" levels. There were no expectations set particularly for these levels. The results are mixed in a number of ways. Yet, there was actually more here than anticipated.

The results coming from Developed States are relatively straightforward. The results of the same linear model employed earlier are see in Table 11. While this work's initial expectations were for the group of countries as a whole, it is fascinating that this model varies so much from the first analysis. Of the control variables, the only completely consistent result was Aid. This is a relatively benign finding, however, because the result was insignificant in each model. Further, this half contains the OECD

Table 11: Results of Linear Interventionism for Developed States

Number of obs =	**725**
F(4, 719) =	.
Prob > F =	.
R-squared =	0.2148
Root MSE =	0.01216

REI	Coef.	Robust Std. Err.	t	P>t	Beta
Intervention	-0.000078	0.000015	-5.170	0.000	-0.093
Democracy	-0.000042	0.000088	-0.480	0.634	-0.017
Economics	0.000000	0.000000	5.220	0.000	0.392
Education	0.000168	0.000050	3.380	0.001	0.089
Aid	0.000000	0.000000	-1.220	0.223	-0.024
_cons	-0.015186	0.004120	-3.690	0.000	.

countries that provide the developmental assistance and aid. From there, however, the results become increasingly significant.

The Economic variable, to start, in and of itself constitutes a significant finding. First, Economics carried the largest beta weight in Developed States (a 0.392 which indicates moderate strength). As such, it stands to reason that for these countries, the largest barrier to RED is Economics. Not only does this fall opposite the findings of Analysis 1, but it seems to make the relationship even more complex. The logic of the literature suggests that this relationship indicates a barrier. The countries that the UNDP reports as doing the "best" at human development support a remarkably strong positive relationship. This finding, then, leads to two questions: 1) Is a positive relationship a barrier; and 2) How can a variable with a negative coefficient in the first analysis be positive at this level?

The answer to the first question is no; a positive relationship at this level does not indicate a barrier. The results show that the higher the level of PPP, the better a country in this half will do at developing renewables. For these levels of development, economics is everything but a barrier. As countries in this half do better economically, they also produce more renewables. What is astonishing is that at this level, the results also fall completely in line with the expectations of the literature. How can economics be significant, positive, of moderate strength and a barrier? Clearly, the literature was looking at developing countries when arguing that economics was a barrier. The point, for now, is that a positive relationship for this half indicates a very different relationship than a positive relationship expected at a lower level of development.

The answer to the second question is less straightforward. There are countries in this half, as seen in the case of the United States, that are doing poorly. As such, the strength of this relationship falls considerably out of line with the theoretical expectations of this work. When looking at specific countries in this half, however, the explanation becomes clearer. The countries that are doing the worst in this half are Kuwait, United Arab Emirates, Oman, Saudi Arabia, and Venezuela. Not only do these countries rank lower on the UNDP scale, but they also have consistently lower levels of PPP than the countries that are doing the best in this half. Their reason for doing so poorly with renewables, however, has little to do with economic means. These cases produce a significant percentage of the world's oil and have less of an immediate imperative for renewable development. Clearly, the effect of these countries provides a reasonable explanation for the strength of the results. In the light of these two explanations, it is important to turn to the results of the second half.

The results for Developing States also provided the researcher with more than expected. The results of the curvilinear model seen earlier are:

Table 12: Results of Curvilinear Interventionism for Developing States

Number of obs =	**844**
F(5, 837) =	.
Prob > F =	.
R-squared =	0.0715
Root MSE =	0.0282

REI	Coef.	Robust Std. Err.	t	P>t	Beta
Curvilinear Intervention	0.000004	0.000002	2.550	0.011	0.281
Intervention	-0.000684	0.000196	-3.490	0.001	-0.435
Democracy	0.000536	0.000117	4.580	0.000	0.106
Economics	0.000001	0.000001	1.560	0.118	0.073
Education	0.000005	0.000039	0.120	0.907	0.003
Aid	0.000000	0.000000	-1.930	0.055	-0.038
_cons	0.025483	0.005586	4.560	0.000	.

The results of Developing States are largely opposite those in Developed States. This is reasonable. Again, it makes no sense that each half contains the entire range of observations from which the expectations for the whole were derived. That said, this half also show a number of surprising results.

Looking first at the variable for Aid, this is the only model in which this indicator is significant. The strength of the relationship is undeniably weak and negative. The literature, however, expected that Aid would be a bear a positive relationship of moderate strength to RED. It makes intuitive sense that the more Aid a country receives, the more start-up capital would be available to them. Clearly, these results were negative. What, then, does availability of start-up capital in the form of PPP say for this analysis?

In light of the previous discussion, the results for economics are also surprising. The variable is insignificant at this level. This is remarkable considering the results of the first analysis and those of the other half. Increases in PPP would also suggest a greater availability of start-up capital. Its insignificance, therefore, gives mixed signals. Like Developed States, however, Developing States contains a number of oil producing nations. Unlike Developed States, countries like Iran and Nigeria exhibit higher levels of Human Development than many of the other countries in this half of the data. While the result is interesting, there are few oil producers on this list. When looking at the data, there are an entirely different group of countries that compel the second half of this explanation.

In retrospect, many of the countries found in the list of countries without REI in 2006 belong to Developing States. Further, three of the members of the Top 10 fall in this half (Benin, Philippines, and Kenya). The most poignant example, Benin, ranked Number One in REI in 2006. Benin, however, can be found near the bottom of the UNDP's list. When combined, the presence of oil producers, the overarching general lack of renewables in Developing States, and three members in the top ten combine to provide a much more reasonable explanation that previously though. However, when combined with Aid, it is clear that a more in depth discussion is necessary.

There are actually a number of possible explanations for these findings to contrast so greatly with the earlier analyses. The first follows the logic of the economic barriers to RED. While this particular analysis saw divergent results, logic suggests that there is an unidentified level of Economics at which renewables make sense. It also makes sense that the countries that are receiving the most Aid are the least developed. Could it be

that the countries receiving the most Aid have yet to reach a level at which they can begin to develop renewables? Unfortunately, this answer would require a full analysis of the reasons for which OECD countries give specific countries Development Assistance and Aid, and is beyond the scope of this research

Those familiar with the topic, however, need little imagination to tie this into the second reason. This half, the less developed, is the subject of a great body of literature. This literature provides insight into these results in a number of ways. First, there are a number of questions in the literature that surround the success of Aid. In fact, a number of scholars question whether it actually leads to Economic Development. If Aid does not lead to development, these results make much more sense. Theoretically, if Aid fails to get countries to a level at which they can begin to develop their renewable energy potentials, it even makes some sense that this relationship would be negative.

This literature sheds light on both findings. For example, some of the Aid given comes with strings attached. Seen most often in the criticisms of the Structural Adjustment loans of the World Bank, loans have routinely been given with 'conditions.' This literature is vast, but it is worth a quick examination. In doing so, however, it is important to take a brief step back. While this paper is ultimately about renewable energies, the literature provides insight into both the Economic and Aid puzzles seen in this half of the results. It is therefore important to start with the broader discussion surrounding the effects of international liberalization.

The liberalization of trade and finance has increased the level of competition in a number of places. The effects of liberalization are the subject of a large body of literature. Underhill, for example, observes that transnational interests can

advantageously structure markets through a systematic capture of the policy process (1998, 18-25). In a more recent study, Underhill argues, "Under conditions of transnational integration, the monetary and financial system (and its associated national entities) will be structured largely along the lines of the way in which the provision of credit is created, allocated, and regulated in dominant financial centers..." (2001, 278). Combined, these lead him to show both how much pressure this can put on a particular economic system, and that there is little neutrality in shaping the infrastructure of that system through both practice and the policy process (ibid, 278).

In general, restructuring economies takes time. Undue pressures can complicate the process. In terms of OECD, then, what can be said? The Official Development Assistance and Aid of OECD members can be differentiated from the Structural Adjustment loans of the World Bank. However, these processes affect the markets in question. Lockhart observes that contradictory outcomes have created concerns around, "… a lack of coherence between aid, trade, finance, security, immigration and drugs policy," and that, "it is impossible to achieve certain policy goals without mobilizing a range of complimentary policies," (2005, 1).

The OECD is also far from neutral. The Policy Coherence for Development (PCD) and Multilateral Agreement on Investment (MAI)(which ultimately generated catastrophic opposition) are just two examples. The PCD sought the integration of the agenda for aid with agendas for the integration for trade, security, and private sector investment (see Lockhart). The MAI, though failed, would have required all countries to open foreign investment and ownership, the equality of treatment for international and domestic firm, the removal of performance requirements, the unrestricted movement of

capital, etc. (for more, see Dicken, 2007, 537). OECD policies are hemispheric in nature, and many agree that they unfairly privilege Transnational Corporations (TNCs) over domestic businesses.

There are also a number of works questioning the effectiveness of Aid itself. For example, Ovaska finds that "…the results from the fixed effect (FE) model with group dummy variables and period effects indicated a *negative* relationship between development aid and economic growth," (italics in original, 2003, 186, see also Boone, 1996). While a number of studies on the topic find diverging results (see, for example, Dalgaard, Hansen, and Tarp, 2000 and Burnside and Dollar, Hansen an Tarp 2001), even those that find positive relationship note that their results are sensitive to both econometric model selection and choice of regressors (Ovaska, 2003, 177). As such, it appears safe to say that Aid does less for economic development than originally anticipated.

Clearly, global market and finance liberalization, the influence of biased institutions, and the general lack of Aid successes bear a number of influences upon the economic development in any country in Developing States. These forces also begin to shed some light upon the renewable context. In returning to a telling observation of the assistance given by IFI and donor states, Geller notes that, "the World Bank and bilateral donors have at times been criticized for failing to build an infrastructure that is capable of marketing and supplying solar energy and other sources of renewable energy devices over the long run once a particular "development project" ends," (84, see also Martinot et al. 2002, Mulugetta, Nhete and Jackson 2000). In many ways this is the final piece of the puzzle.

For now, it is sufficient to say that the success of renewable energies, already at a competitive disadvantage, is further complicated by a number of exogenous forces. These forces manifest themselves in a number of different ways. Ultimately, this suggests that the success of renewables can be impaired in a great variety of ways when dealing specifically with the countries in Developing States. Further, this helps to explain why the contradictory findings of both Economics and Aid are evident at this level. It may not be a satisfactory refrain, but one is left concluding that more research along these lines is certainly necessary.

There is one final relationship from this half in need of discussion. Democracy, significant at the .001 level, was also the strongest variable in this half. This is opposite the insignificance found in the first half, but falls completely in line with both the expectations of the literature and those of the theoretical development of this work. For this half, the more democratic the country, the better they will do at developing REI. Democracy, it seems, is the closest to describing a barrier at this level.

In the end, the second analysis does seem to empirically confirm the contextually bound discussions seen in the literature. For example, the level of development matters for Developing States. Most clearly seen in the discrepancies between the results for the Economic indicators in each half, the results were almost contradictory. The same can be said for aid. In moving forward with this research, however, it is important to exercise caution.

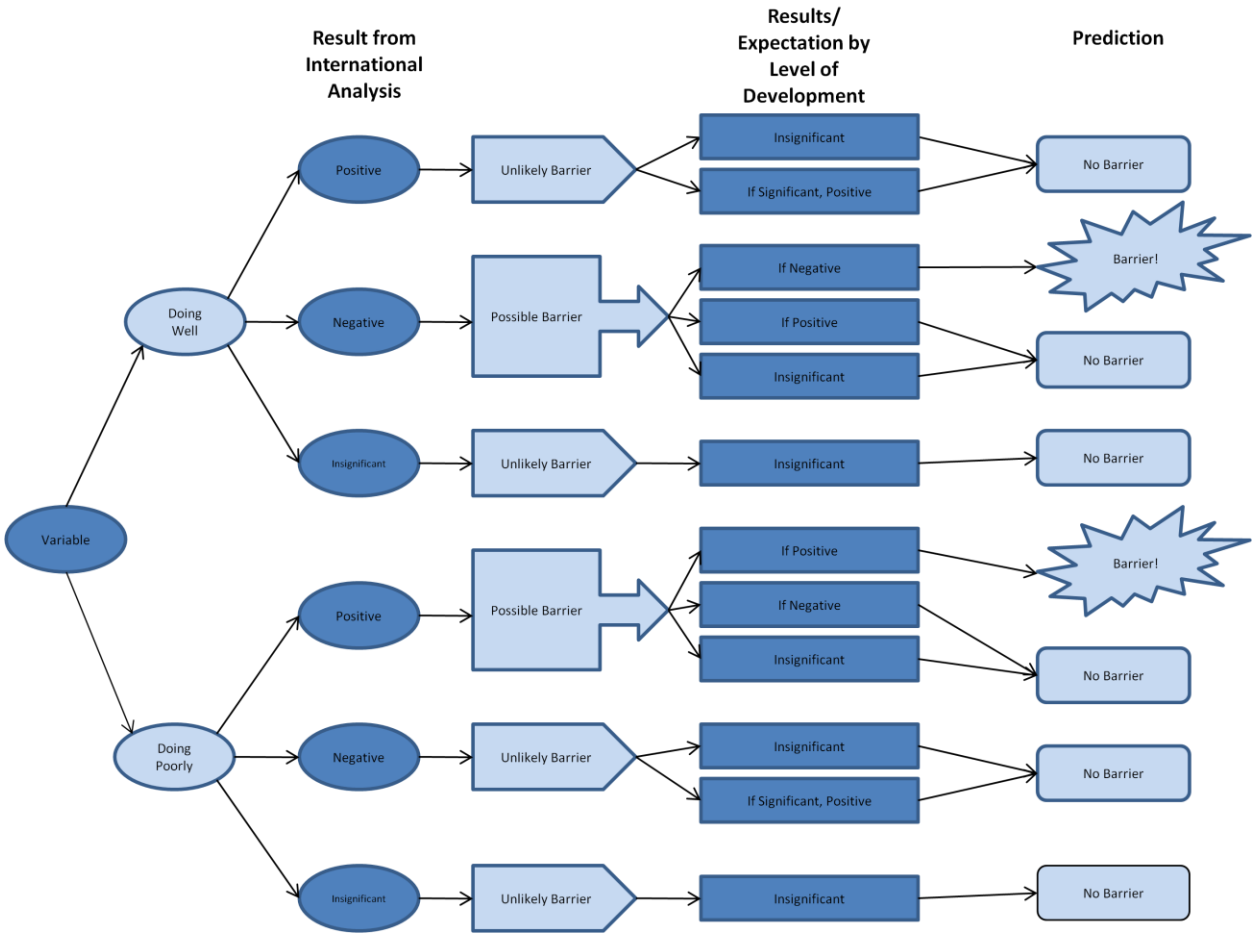
In these cases, as the analysis disaggregated the data, the results changed. This was to be expected. However, the justifications for the divergent results poignantly illustrate the problem. In the case of the Economic indicator, the contrasting results left

the discussion with changing expectations and divergent results. Further, the discrepancies in these results really began to make sense only when looking at the effects of individual countries. The justifications for these results were ultimately grounded in the effects specific countries have upon those results. Admittedly, the motivation for more context specific understandings may be inherently motivated by the quest for more ideographic knowledge. However, the move away from nomothetic understanding ultimately gives the student of the international barriers less and less to work with.

There is one final point mentioned earlier that is in need of further discussion. Looking back, it was clear that economics was supposed to be a barrier to RED. This was not the case for the more developed countries. It was positive and significant. Because they are doing better, the relationship did not indicate a barrier. What this means is simple: the way one interprets the barriers to RED depends upon countries' standing. A negative relationship for developed countries is a barrier, while a positive relationship for the developing tells the same story. Because these variables play out differently at different levels of development, the implications are contingent upon development.

In tying the results together, a pattern emerges. In fact, the international analysis appears to tell differing levels of development most of what they need to know. One can predict, with relative certainty, whether a particular barrier will be of interest to a level of development. Armed with the expectations for that level, the level's respective position on a variable and the international result, one can largely predict whether a variable is of any importance. For example, if the expectation is positive, the group of countries is doing well, and the international relationship is significant and positive, it is unlikely that the variable will be a barrier. This is best described in the following chart:

Figure 7: Framework for Understanding the International Barriers to Renewable Energy Development



When broken apart by variable, the international analysis should show whether there is a need to look further. If a barrier is possible, the results and expectations are telling. There is no need to rely upon a dataset with decreasing sample sizes and increasing uncertainty.

Turning to the results, does this flow chart accurately describe patterns in the data? Economics is a telling case. At the international level, the relationship is significant and negative. For a country this is doing well, at a level for which the expectation is positive, the results would be either insignificant or if significant positive. This level should not expect that this is a barrier. The results actually confirm this. The

Relationship between REI and Economics for Developed States are positive. Economics do not act as a barrier for countries at this level of development. For a developing country, however, the international result is of considerably more interest. Interestingly, for this level, a barrier is expected be positive. While the variable is insignificant at this level, both ultimately show that economics do not act as barriers at this level. Following the flowchart logically would have led one to the same conclusion.

These patterns are actually quite significant. It is therefore worth discussing each variable in turn. Following the logic solely, what would the findings for Democracy suggest for countries on opposite ends of the political spectrum? For an advanced democracy, there would be no need to concern themselves with the findings. They are doing well on the variable, a positive relationship is not a barrier, and this variable would be of no interest. If significant, they would expect a positive relationship at this level. For a more autocratic regime, however, a positive relationship and expectation signals a barrier and is of particular interest. Admittedly, the halves were not divided along political lines and the test is imperfect. However, the aggregates ideologies of these halves seem to confirm this logic. When looking at the results, Democracy is insignificant for those in Developed States and a barrier in Developing States.

Education, then, is the next test. Again, following the logic, countries that have sophisticated levels of education would not need to look at this barrier, and the relationship should be positive if significant. This particular finding would be of interest to countries that are not doing well, because it is negative. For Developed States the relationship is positive and significant. For Developing States, the relationship is insignificant.

The final variable, Aid, also falls in line. Due to its insignificance, it would not logically appear to be a barrier at any level. In fact, as the analysis largely suggests, Aid does not appear to be a barrier to RED at any level. The variable is only significant for Developing States, and a negative relationship indicates that the Aid has an effect on REI opposite that proposed in the literature.

Within this framework, the international analysis can be very telling. Different countries will interpret the result differently. While disaggregating the data seems justified, it is not necessary. The results of this study show that the international analysis is all the evidence necessary. Depending upon relative position at each variable, one can find what they need to know without breaking the dataset down. Further tests of this framework may be necessary. For now, however, this should be the basis from which any discussion of the international barriers to renewable energy development proceeds. While there are certainly contextual differences and the barriers specific countries will face will vary, the larger model does much more than anticipated. Once scholars allow for different expectations, the results of one model processed through this framework are consistent with the disaggregated results. That said it is still unclear how interventionism will play into this framework. More research along these lines is certainly necessary.

Conclusions:

The results of these analyses tell a number of interesting stories. They also lead to a number of conclusions with increasing specificity. The first story is that the empirical approach to the barriers to renewable energy is entirely plausible. This research shows that when looking at the international level, there are significant variables influencing RED. The theoretically derived model also entertains support. Empirically, it makes sense to talk about the international barriers to renewable energy development. In the future, however, it is clear that improved specification is necessary.

Relatedly, the second lesson is that the largest barriers to renewable energy development *may* still be enabling policies and regulatory frameworks. However problematic, the interventionism variable (in either its' linear or curvilinear form) was significant in every analysis and Bayesian Model selection. At the very least, this work indicates that the relationship between enabling policies and regulatory frameworks and RED is especially interesting. While the hypothesized relationship found little support here, it remains largely tenable.

The third result is that GOE is woefully inadequate. There are problems with these data. The distribution of the data from a single source and the data from which the source is inconsistent seem to favor a negative relationship between REI and GOE. This favor is unjust, and the data may potentially magnify the impacts of this data. Future research on this and other topics should exercise appropriate caution when dealing with this data.

Fourth, looking at the international level tells a number of stories. Primarily, democracy is of special importance. There is a significant and positive relationship

between democracy and RED, and the political barriers to renewable energy development are worth further research. Economics is also significant and negative. At this level, this also leaves the cost-based technological discussions as suspect. In going forward, there is a need to examine these relationships more closely.

Finally, the barriers to renewable energy do seem to depend upon the level of development. In fact, this is especially true of the way that they are discussed and hypothesized. When talking about the international barriers to RED, which variables are important to a particular country depends upon its level of development. A country that is doing poorly will look at a positive relationship between PPP and REI differently than a country that is doing well. A positive expectation for the developed world is fundamentally different than a positive relationship for the developing. This is not to say that there are not international barriers. In fact, the framework shows the opposite. From within this framework, one can generally predict which barriers will be significant for different levels of development as long as the expectations of what constitutes a barrier at that level are appropriate. While there are certainly areas of grey in the middle, this framework gives the current literature a theoretical boost based upon empirical grounds.

There are, admittedly, a number of other questions for research that this work brings to the fore. While further specification is undoubtedly necessary, these analyses stand as an important first step. Additionally, these analyses were largely guided by both the extant literature and the available data. In moving forward, there are at least two areas that appear increasingly relevant to any discussion of the international barriers to renewable energy development.

First, it is clear that many countries are starting to use a new approach to renewable energy development. As Komor notes, "A growing number of countries are using a very simple approach to get new renewable capacity built: They are setting a mandatory goal for renewable content and letting the market find the least expensive way to get there," (2004, 156). This approach, a renewable portfolio standard (RPS, also called renewable obligation and quota), has political support and is favorable for both proponents of the free market and of renewable advocates who find clear goals amiable. While only 25 countries have adopted RPS's by 2005, further empirical research along these lines will become increasingly relevant.

Second, there is also something interesting about the flows of investment surrounding renewable energy. While renewable energy investment globally was around US$ 7 billion in 1995, it has grown steadily (Ren21, 2005, 14). By 2004, this amount totaled around US$30 billion and was around 20-25% of the total power sector investment that year with $150 billion going to conventional power sector investment (Ren21, 2005, 14). Investments have increased quite drastically in recent years, and in 2008 global renewable energy investment was over four times that of 2004 (UNEP, 2009, see also Ren 21, 2007 and 2009). While these increases in investment are encouraging, especially for advocates of renewable energies, the recent and significant rates of sustainable energy investment growth seem to have been slowed by the current global financial crisis. According to the United Nations Environment Program (UDEP), for example, "In the first quarter of 2009, new financial investment fell by 53% to $13.3 billion compared to the same period in 2008, the lowest level of quarterly investment for three years," (2009, 3). While future work will undoubtedly be able to tell us more, it

seems unjust to speculate what this means for sustainable or conventional energy investment.

The analysis also highlighted that despite the perceived irrelevance of the 'technology' debate, renewables are still at a competitive disadvantage. While the discrepancies between renewable energy investment and conventional energy investment have narrowed, the current economic climate gives no clear indication as to the trajectories that investment will follow. It is, admittedly, unfortunate that this analysis cannot take into account the years in which investment has been at the highest. However, it does seem that any trends that are observed in 2005, while the investment was increasing, should hold. As such, further empirical research along these lines may also be necessary.

The future for international renewable energy development is far from certain. There are a number of questions that remain and the volatility of the global financial context complicates matters considerably. That said, renewables are ever more viable, are increasingly seen as one solution to a number of problems, receive increasing normative favor. The future, thus, looks bright, and even more so for developing nations. As Volpi suggests in a hopeful summary, "In [developing] countries, renewables are most often the most economical choice in rural areas – where it would be too costly to bring in the grid- while simultaneously offering a clean 'leap' over fossil fuels. Their modular nature and distribution mean that they can be built (and paid for) as demand for energy grows… Finally, renewables offer direct environmental benefits, in terms of improved indoor air quality, available drinking water and of course green house gas emissions," (2005, 86).

Works Cited

Babbie, E. (2006) *The Practice of Social Research 11th Edition*. Belmont: Wadsworth Publishing.

Boone, P. (1996). Politics and the Effctiveness of Foreign Aid. *European Economic Review.* 40:289-329

Burnside, C., and Dollar, D. (2000). Aid, Policies, and Growth. *American Economic Review.* 90:847-68.

Clay, R. (2002). Renewable Energy: Empowering the Developing World. *Environmental Health Perspectives* , 30-33.

Dalgaard, C.-J., Hanson, H., and Tarp, F. (2000). Aid Effectiveness Disputed. *Journal of International Development*. 12:375-98.

Dicken, Peter. (2007). *Global Shift 5th Edition.* New York: The Guilford Press.

Elliot, D. (2000). Renewable energy and sustainable futures. *Futures* 32: 261-274.

(2005). Comparing Support for Renewable Power. In V. Lauber, *Swithing to Renewable Power: A Framework for the 21st Centiry* (pp. 1-268). London: Earthscan.

G8 Renewable Energy Task Force (2001). *Renewable Energy: Development that Lasts-Chairman's Report,* Rome, Italian Ministry of Environment.

Geller, H. (2003). *Energy Revolution: Policies for a Sustainable Future*. London: Island Press.

Goldemberg, J. (1992). Energy, Technology, Development. *Ambio* , 14-17.

Gwartney, J., Lawson, R., and Block, W. (2006) *Economic Freedom of the World.* Vancouver: Frasier Institute. (Data retrieved from www.freetheworld.com.)

Hansen, H., and Tarp, F. (2001). Aid and Growth Regressions. *Journal of Development Economics*. 64: 647-70.

Johansson, T., McCormick, K., Neij, L., and Turkenburg, W. (2004). The Potentials of Renewable Energy: Thematic Background paper. *International Conference for Renewable Energies.* Bonn.

King, G., Keohane, R, and Verba, S. (1994). *Designing Social Inquiry: Scientific Inference in Qualitative Research*. New Jersey: Princeton University Press.

Knowles, S., and Garces-Ozanne, A. (2003). Government Intervention and Economic Performance in East Asia. *Economic Development and Cultural Change*. 51(2):451-477

Komor, P. (2004). *Renewable Energy Policy*. New York: Diebold Institute for Public Policy Studies.

LaPorta, R., Lopez-de-Silanes, F., and Shleifer, A. (2000). Government Ownership of Banks. *Working Paper 7620: National Bureau of Economic Research*. http://www.nber.org/papers/w7620.

Lockhart, C. (2005). From Aid Effectiveness to Development Effectiveness: Strategy and Policy Coherence in Fragile States. *Background paper prepared for: Senior Level Forum on Development Effectiveness in Fragile States*. Overseas Development Institute: 1-8.

Marshall, Monty G. and Keith Jaggers. 2002. Polity IV Project: Political Regime Characteristics and Transitions, 1800-2002. http://www.cidcm.umd.edu/inscr/polity/index.htm.

Martinot, E., Chaurey, A., Lew, D., Moreira, J., and Wamukonya, N. (2002). Renewable Energy Markets in Developing Countries. *Annual Review of Energy and the Environment.*27:309-348.

Mauro, P. (1995). Corruption and Growth. *The Quarterly Journal of Economics*. 110(3):681-712.

Mulugetta, Y., Nhete, T., and Jackson, T. (2000). Photovoltaics in Zimbabwe: Lessons from the GEF Solar Project. *Energy Policy.* 28:1069-1080.

Ovaska, T. (2003). The Failure of Development Aid. *Cato Journal*. 23(2):175-188.

Owen, A. (2006). Renewable Energy: Externality Costs as Market Barriers. *Energy Policy* 34:632-642.

Painuly, J. (2001). Barriers to renewable energy penetration: a framework for analysis. *Renewable Energy* 24:73-89

Raftery, A. (1995). Bayesian Model Selection in Social Research. *Sociological Methodology*. 25:111-163

REN21. (2006). Renewables 2005 Global Status Report. Paris: REN21 Secretariat and Washington, DC:Worldwatch Institute.

(2008). Renewables 2007 Global Status Report. Paris: REN21 Secretariat and Washington, DC: Worldwatch Institute.

(2009). Renewables Global Status Report: 2009. Update Paris: REN21 Secretariat: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH.

Rodrik, D. (2005). Why We Learn Nothing From Regressing Economic Growth on Policies. Harvard University [From: dev.wcfia.harvard.edu].

Trachtenberg, Z. and Focht, W. (2005). "Legitimacy and Watershed Collaborations," in Sabatier, P. et al. eds, *Swimming Upstream: Collaborative Approaches to Watershed Management*. Cambridge: MIT Press.

Underhill, G. (1999). Transnational Financial Markets and National Economic Development Models: Global Structures versus Domestic Imperatives. *Economics et Societes. Serie Monnaie, ME no. 1-2, Septembre et Octobre(37-68).*

(2001) The Public Good versus Private Interests. In Drache, D. ed., *The Market or the Public Domain: Global Governance and the Asymmetry of Power* (1-394). London: Routledge.

UNEP(2009). *Global Trends in Sustainable Energy Investment 2009: An Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency.* New York: UNED, SEFI, and New Energy Finance.

UNDP (2000). *World Energy Assessment- energy and the challenge of sustainability.* New York, UNDP, World Energy Council, and UNDES.

Volpi, G. (2005). Renewable Energy for Developing Countries: Challenges and Opportunities. In V. Lauber ed., *Swithing to Renewable Power: A Framework for the 21st Centiry* (pp. 1-268). London: Earthscan.

Wacziarg, Romain (2002). Review of Easterly's *The Elusive Quest for Growth*. *Journal of Economic Literature*. XL: 907-918.

Appendix A:

To begin the analyses, this work tested the curvilinear relationship. Undertaken to examine whether the analysis should proceed further, the results indicated that the model was significant and worth further exploration. After entering all of the variables in the model, this work set about evaluating the regression hypotheses. The results of the initial model were:

Source	SS	df	MS
Model	0.030	6.000	0.005
Residual	0.413	1497.000	0.000
Total	0.443	1503.000	0.000

Number of obs =	1504.000
F(6, 1497) =	18.080
Prob > F =	0.000
R-squared =	0.068
Adj R-squared =	0.064
Root MSE =	0.017

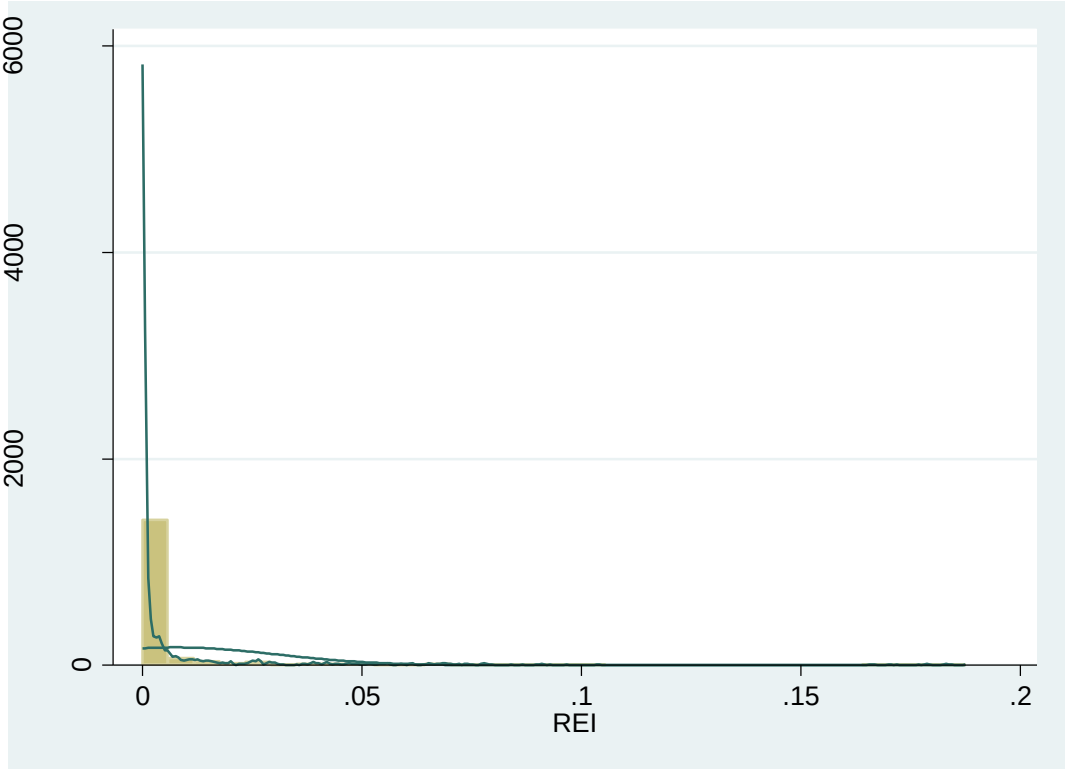
reinohyd	Coef.	Std. Err.	t	P>t	Beta
Curvilinear Intervention	0.000	0.000	2.840	0.005	0.271
Intervention	0.000	0.000	-4.800	0.000	-0.473
Democracy	0.000	0.000	4.950	0.000	0.141
Economics	0.000	0.000	-2.640	0.008	-0.084
Education	0.000	0.000	-2.480	0.013	-0.080
Aid	0.000	0.000	0.820	0.414	0.022
_cons	0.020	0.003	7.680	0.000	.

The model was significant.

The project then examined the distribution of the dependent variable. The variable was not normally distributed. This is unsurprising because, as seen earlier, there

are few countries that are successfully developing renewable energy portfolios. As such, it does not come as a shock that most of the observations exhibit low levels of RED. The project moved on to evaluate the normality of the D.V. Understandably, REI was positively skewed (4.92). It was also clear that, with a Kurtosis of 31.87 (normal being 3.0), the tails were very thick.

The distribution of REI:



The results of the test for normality of the D.V.:

	Percentiles	Smallest
1%	0	0
5%	0	0
10%	0	0
25%	0	0
50%	0.000037	
		Largest
75%	0.002341	0.183009
90%	0.022271	0.183404
95%	0.050318	0.184465
99%	0.104198	0.187545

Obs	1707
Sum of Wgt.	1707
Mean	0.007611
Std. Dev.	0.023066
Variance	0.000532
Skewness	4.922522
Kurtosis	31.87631

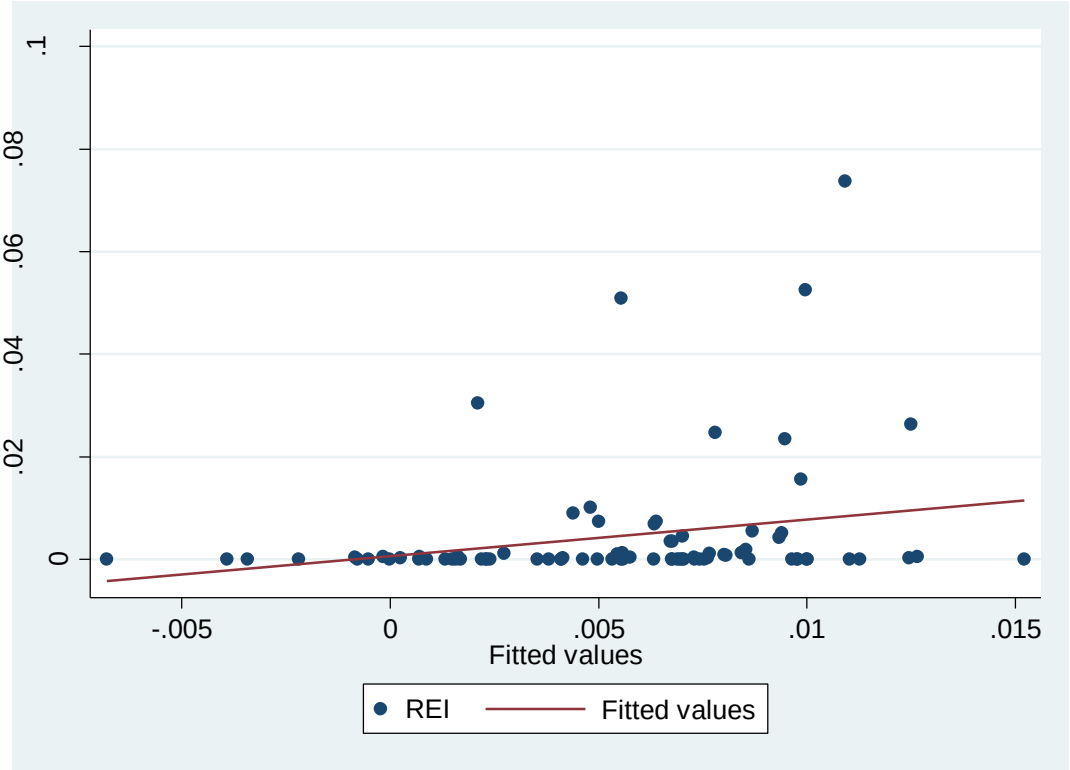
In order to tell the significance of these coefficients, this work tested Skewness/Kurtosis normality. The results were as follows:

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj	chi2(2)	Prob>chi2
REI	1700	0.000	0.000		.	.

When combined with the above summary, this indicates that Skewness = 4.92, $p < 0.001$ and Kurtosis = 31.87, $p < 0.001$. Jointly, they exhibit a probability of $p < 0.001$ indicating that the distribution is not normal, the results are positively skewed, and the tails are thick.

This analysis then went on to evaluate the distribution of the residuals. Here is a scattergram of the regression line with a sample of 100:[11]

[11] This was done by running the regression, predicting reihat (a score for each observation based upon the regression equation), set a seed of 111, drew a random sample of 100 cases, and two way graphed the results.



Due to the distribution, skew, and an analysis of the residuals, it was exceedingly clear that the data were problematic and needed to be transformed. However, there was a problem. Because REI is a percentage from 0 to 1, the common transformation procedures do little to normalize the data. For example, taking the natural log (after adding a constant requisite for numbers between 0 and 1) did not shift the Skew nor Kurtosis in any meaningful way. This work attempted a series of log transformations (natural log and log(10)), square root, inverse and arc-sine transformations. The most promising, arc-sine, was still insufficient. The work then employed the Box-Cox method,

but found nothing helpful. In the end, none of these transformations worked, and the remainder employs Robust Standard Estimates (RSE) to compensate for the irregularity.

The analysis then ran diagnostic tests. In searching for unpredictable cases, the analysis employed post estimation commands.[12] The results indicate that there are no outliers or influential cases (dfbeta). There are no problematic observations.

The final diagnostic was a test of multicollinearity. In testing multicollinearity, the analysis then calculated the Variance Inflation Factor (VIF). Unsurprisingly, the two variables that were highly correlated were GOE and the squared variable for assessing the collinear relationship. When either variable was dropped from the regression equation the results indicated no multicollinearlity. Here are the results:

Variable	VIF	1/VIF
Intervention	15.64	0.064
Curvilinear Intervention	14.6	0.068
Education	1.67	0.597
Economics	1.62	0.619
Democracy	1.3	0.767
Aid	1.18	0.848
Mean VIF	6	

This indicates that multicollinearity is not a problem for this analysis.

Finally, the work tested the validity of REI as the D.V. The best way to do this was to evaluate each arm of REI separately. The work ran the specified model for both renewable energy as a percent of total energy production and renewable energy as a

[12] Done by predicting yhat, resid, rstandard, and the listing the results for which all of the cases for which the standardized residual was greater than 2.58 (the z-score corresponding to two-tailed level of .01 significance)

percentage of total energy consumption. The results of each were remarkably close to those of the entire model. Therefore, using REI as an average of the two did not affect the results in any significant way.