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Exploratory analysis of prospects for renewable energy private investment in the U.S.

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ABSTRACT

Opportunities for private investments in renewable energies were explored using a stated-preference investment allocation instrument. Allocation alternatives included conventional and renewable energy investments. Among renewable energy investments, solar and wind energy were ranked the highest while grass and wood-based technologies were at the bottom of the renewable energy list. This ranking mirrors the allocation of investments in sustainable energy technologies in global markets. Results were analyzed using a two-limit tobit model which suggests that certainty of investments, a diversified portfolio and expectation on financial returns were the primary drivers behind funds allocated to renewable energy investments. Using cluster analysis, twenty-three percent of our sample of current and future investors was identified as individuals most willing to invest in renewable energies.

1. Introduction

Global demand for and investments in renewable energy have grown significantly in recent years. According to Faundez (2008), an estimated US$16 trillion would need to be invested in the world's energy systems over the next 25 years in order to satisfy an expected 60% growth in energy demand. The United Nations Framework Convention on Climate Change (UNFCCC, 2007) has estimated that US$200–210 billion in investments will be required annually by 2030 to meet global greenhouse gas emissions reduction targets. Global investments[1] in sustainable energy exceeded US$155 billion in 2008 (United Nations Environmental Programme-UNEP, 2009). Investments in new energy generation projects (e.g. wind, solar, biofuels etc.) worldwide accounted for US$116.9 billion. New investments in companies developing and scaling-up new technologies, including energy efficiency, increased to over US$23 billion in 2008 (UNEP, 2009). Capital raised via public stock markets for equipment manufacturing and project pipelines was estimated at US$11.4 billion, while capital raised through private equity expansion was estimated at US$7.4 billion in 2008 by the UNEP (2009).

Rates of growth and total investments vary depending on type of energy and financial instrument. The highest growth rate among investment categories was in public markets, where investment was 80% higher in 2007 than in 2006 (New Energy Finance, 2008). However, investment in clean energy firms via public stock markets dropped 51% (to US$11.4 billion) in 2008, down from US$23.4 billion the previous year as a result of the crash of stock markets around the world (UNEP, 2009). The UNEP (2009) reports that wind attracted most new investments (43%), followed by solar energy (28%) and biofuels (14%) in 2008. Biomass and waste technology accounted for 7% of total global new investments in sustainable energy. Wind energy investments also experienced the fastest growth (123%) between 2007 and 2008. However, solar technology attracted the most venture capital and private equity investment (US $5.5 billion) and captured most new investments through public markets (US$6.4 billion).

Developed and developing nations are engaged in substantial efforts to attract sustainable energy investments. According to the UNEP (2009), total new investment in developed countries in 2008 was US$82.3 billion (1.7% down from 2007) and in developing countries was US$36.6 billion (27% higher than 2007). Investments in sustainable energies were about US$49.7 billion in Europe and about US$30.1 billion in the U.S. in 2008 (UNEP, 2009). While European investments increased 2%, North American investments shrunk by 8% as a consequence of the economic recession. In other parts of the world, Brazil increased energy investments by 76% reaching an estimated US$10.8 billion. The Chinese government allocated US$15.6 billion towards sustainable energy investments (18% growth compared to the previous year) and India invested an estimated US $3.7 billion (12% growth). Energy investments in Africa totaled US $1 billion (10% growth) in 2007. The UNEP (2009) has also estimated that support for sustainable energy efforts in fiscal stimulus packages around the world reached US$180 billion in 2008.

Public and private investments are projected to continue to grow in spite of the grim economic environment. As a case in point, solar power investments have grown at an average 25% every year for the last 15 years,

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[1] Global investments in sustainable energy included the following categories: venture capital and private equity, public markets, asset financing, mergers and acquisitions.

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30% annually for the last five years (Hasan, 2008). Hasan (2008) also analyzed the growth of the solar power industry and concluded that solar investments may indeed be, at this point in time, the most profitable renewable energy to invest in. Other indications in the market of the profitability of renewable energy investments are new strategies adopted by large commercial banks. Several financial institutions are adding renewable energy investments to their lending portfolios. JP Morgan Chase Bank is managing about 4.4 billion dollars on energy investment, which is currently allocated to wind and solar investments and will be extended to biofuels in the future (Yang, 2008). The National City Bank of New York has established a specific department responsible for the investments in renewable sustainable energy products (Yang, 2008). Many investments and acquisitions have also been made by leading global companies, such as General Electric, Siemens, Shell, British-Petroleum, Sanyo, and Sharp (Renewable Energy Policy Network, 2005).

In the U.S., energy investments are driven by security concerns, efforts toward ameliorating climate change impacts and growing needs for new energy supplies. Such concerns have garnered the interest of Federal and state governments, private industry, as well as investors. In the public policy arena, the U.S. government has approved several pieces of legislation promoting renewable energy sources and facilitating public investments. One of the provisions in the 2007 Energy Independence and Security Act outlined a significant increase in the use of renewable fuels in the United States (Public Law 110-140, 2007). This Act requires an increasing reliance on “advanced biofuels”, non-food fuel feedstocks, to avoid raising the cost of food to produce renewable energy. Between 2001 and 2005, the United States Department of Agriculture (USDA) spent nearly US$1.7 billion on energy-related programs. In 2006, it spent more than US$270 million in several renewable energy areas including commercialization, research, development, and technical support (USDA Economics Research Service, 2007). The U.S. Department of Energy has taken an active role supporting sustainable energy initiatives. Most recent announcements include US$24 million in Wind Energy Research Facilities investments, US$87 million in funding to support solar energy technologies, and up to US$750 million in funding from the American Recovery and Reinvestment Act to accelerate the development of conventional renewable energy generation projects (DOE, 2009).

Public investments will be instrumental to developing technologies and supplying renewable energy. Nonetheless, a combination of private and public financing will be necessary to meet energy demand and emission reduction objectives. Household investment is a complementary input in market production to business capital and labor (Fisher, 2007). As suggested by the International Energy Agency (2009) households and businesses are responsible for making required energy investments, but governments' role will be critical to facilitate a mix of energy investments. The UNEP (2008) suggests that typical leverage ratios for public and private funding range from 3:1 to 15:1. Moreover, the study of household preferences for financial investments to provide capital following a recession, as the world has recently experienced, is encouraged by past literature. Fisher (2007) suggests that in seven of the ten postwar recessions, household investment reached its peak before businesses did.

The study of private investment preferences for renewable energies, thus, deserves attention to determine potential opportunities to spur economic development in conjunction with public support. This research was motivated to explore the characteristics of potential individual sustainable energy investors and to assess how competitively sustainable energy investments are perceived to be compared to traditional investment instruments. Specific objectives for this study included to: (a) estimate the ranking of renewable energy investments as they compare to traditional investments instruments (e.g. interest producing investment including bonds, certificates of deposit, mutual funds, etc.); (b) elucidate demographic and attitudinal characteristics that influence personal investment preferences in renewable energies; (c) assess the potential for a niche market of renewable energy investors in the U.S.

This manuscript first introduces the theoretical framework on which statistical analyses were based on. Then, research methods specific to each research objective are outlined. The Results section includes data for different tests statistics and the Conclusions highlight the implications of our results. This research contributes to the growing literature on the study of consumers and investments' preferences for green energies (Roe et al., 2001; Zarnikau, 2003; Bergmann et al., 2006; Borchers et al., 2007). It is unique in the use of analyses that estimate actual dollar investment amounts, outline the profile of renewable energy investors, and suggest estimates of a potential niche market of investors in the U.S.

2. Research framework and methods

2.1. Theoretical framework

A random utility model was the foundation for the analysis of this research. It was assumed that private investors have a limited investment budget that is allocated in a fashion that maximizes their utility. A utility function captures factors influencing resource allocation comprised of a deterministic component and a random error (Hanemann, 1984). The utility (U) for the ith individual derived from investments can be expressed as:

$$U_i = x'_i\beta + \varepsilon_i \tag{1}$$

where β is a vector of unknown parameters for different investment alternatives, x'_i is an information vector describing investment options and individual socio-economic characteristics, ε_i is a vector that represents random errors which are assumed to be independently and normally distributed with mean of zero.

A latent model is used to estimate the value of the β parameters. The derived utility value for individual $i(U_i)$ is not observed directly but it is expressed in the form of an actual budget allocation. This model assumes that monetary investments could be assigned to two categories: traditional interest-generating instruments (e.g. bonds, certificates of deposit, mutual funds, etc.) and renewable energy investments. The budget allocation represents the observed variable in this model and it is assumed to be the allocation that maximizes utility for the ith respondent. Since investment allocation can range from no money allocated to renewable energy investments to the totality of the budget, this model fits the characteristics of censored data. It has a lower limit set at zero and a maximum limit that represents the full allocation of investments to renewable energy options. Therefore, a two-limit tobit model (after Tobin, 1958) was used as the econometric specification to analyze investment alternatives. This model is based on a linear model (Eq. (1)) that relates the explanatory variables to a latent dimension (Maddala, 1983). The empirical model is given by:

$$\begin{aligned} I_i &= L_{1i} \text{ if } U_i \le L_{1i} \\ I_i &= U_i \text{ if } L_{1i} < U_i < L_{2i} \\ I_i &= L_{2i} \text{ if } U_i \ge L_{2i} \end{aligned} \tag{2}$$

where I_i is the actual dollar amount an individual is willing to invest in renewable energies and L_{1i} and L_{2i} are the lower and upper limits in the model, respectively. The marginal effect of a change in the ith explanatory variable on the value of $U(\partial U/\partial x_i)$ was estimated following Wooldridge (2002).

2.2. Empirical model and data collection methods

An empirical model was estimated studying the allocation of US $1000 in investments. This maximum amount was determined to allow comparison of responses among study participants based on the same level of budget availability. It also highlighted a budget constraint that required respondents to select an allocation that maximized their utility and captured potential trade-offs between investment options. Ultimately, the instrument aimed to provide a realistic situation to respondents in order to reduce potential stated-preference bias and elicit more accurate model estimates. One obvious