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The dynamics of returns on renewable energy companies: A state-space approach

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ABSTRACT

The renewable energy sector has accomplished remarkable growth rates over the last decade. This paper examines the dynamics of excess returns for the WilderHill New Energy Global Innovation Index, which lists firms in the renewable energy sector and is used as a global benchmark. We propose a multi-factor asset pricing model with time-varying coefficients to study the role of energy prices and stock market indices as explanatory factors. Our results suggest a strong influence of the MSCI World index and technology stocks throughout the sample period. The influence of changes in the oil price is significantly lower, although oil has become more influential from 2007 onwards. We also find evidence for underperformance of the renewable energy sector relative to the considered pricing factors after the financial crisis.

1. Introduction

The renewable energy sector has accomplished substantial overall growth in the global economy during the last decade. Estimates by the International Energy Agency (IEA) suggest that renewable energy will be the fastest growing component of global energy demand with an annual growth rate of more than 7% within the next two decades (International Energy Agency, 2009). Some of this development may be attributable to the conjunction of government policies, rising oil prices and evolving stock market liquidity for investments in renewable energy companies. Several renewable or clean energy stock indices have been created, including, for example, the WilderHill New Energy Global Innovation Index (NEX), the WilderHill Clean Energy Index (ECO) or the S&P Global Clean Energy Index (SPGCE).

There has also been an increased interest in examining returns of renewable energy companies, as well as in identifying potential drivers of these returns, see, e.g., Henriques and Sadorsky (2008), Kumar et al. (2012), Sadorsky (2012), Bohl et al. (2013) and Managi and Okimoto (2013). These studies typically focus on the relationship between renewable energy stocks, changes in the oil price, other equity indices and carbon prices. The authors typically find evidence for the impact of several of these variables on renewable energy stock prices. In particular, returns of high technology and renewable energy stocks seem to be highly correlated. On the other hand, results are not that clear-cut for the influence of changes in the oil price. While Henriques and Sadorsky (2008) suggest that changes in oil prices have only limited impact on returns from investment in renewable energy stocks, Kumar et al. (2012), Sadorsky (2012) and Managi and Okimoto (2013) find some evidence for a significant relationship between these variables.

In this paper we contribute to this stream of literature by proposing a state-space multi-factor asset pricing model to study the impact of explanatory variables such as oil prices, technology stocks and the MSCI World stock market index on renewable energy stocks. The novelty of our approach is the use of time-varying beta-factors which provide insightful information about the dynamic influence for each of the considered explanatory factors. Our approach also allows us to evaluate the performance of the renewables sector through time in relation to the applied pricing factors.

We believe that results on the impact and significance of the considered pricing factors will not be constant through time. Asset pricing models with time-varying factors in a state-space econometric

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framework have been successfully applied in previous studies, see e.g. Bollerslev et al. (1988), Jagannathan and Wang (1996), Berglund and Knif (1999), Tsay (2005), Koopman et al. (2008) and van Geloven and Koopman (2009). In comparison to a static approach, these models offer additional insights into the dynamic relationship between the variables, as well as information on the time-varying influence of the pricing factors. Compared to approaches based on structural changes or regime switching, our approach benefits from extracting information about smooth changes in the relationship under study. For our analysis of the renewables sector, we would expect significant variation in the estimated coefficients and the relative performance of renewable energy stocks, for instance, during periods of substantial changes in the oil price or a financial crisis.

The second motivating idea stems from the observed significant relationship between financial returns of renewable energy companies and those of oil, equity indices and technological shares, as they have been reported in various studies. To examine this relationship, the most commonly-used methodologies are the CAPM-type, multiple regression or vector-autoregressive models (Boyer and Filion, 2007; Faff and Brailsford, 1999; Henriques and Sadorsky, 2008; Kumar et al., 2012; Sadorsky, 2001). More recently, the use of multivariate GARCH, dynamic conditional correlation models (Sadorsky, 2012) and Markov-switching models (Managi and Okimoto, 2013) has also been suggested.

Our investigation complements this line of research, while employing a different model with time-varying coefficients. Combining the idea of time-varying coefficients with previously identified explanatory factors, in this study we apply a state-space multi-factor asset pricing model. Such an approach will also allow us to study *active* or *abnormal returns* of renewable energy companies, i.e., we can evaluate the performance of the renewables sector through time, relative to the identified pricing instruments. To the best of our knowledge no such approach has been applied previously to the dynamics of the global renewable energy sector that is represented in our study by the WilderHill New Energy Global Innovation Index (NEX). The index has become a major international benchmark index with a market capitalization of over $250 billion[4] that includes worldwide active companies specializing in renewable energy, clean power and energy efficiency.

The use of time-varying beta-factors provides insightful information on the dynamic influence of each explanatory factor. In particular, our results suggest that the impact of the considered variables changes during different regimes, such as: (i) the substantial increase in the oil price from 2001–2008, (ii) the period of the global financial crisis (GFC), and, (iii) the period of recovery in stock markets, which was also characterized by reduced expectations of government subsidies to the renewable energy sector. Our results also complement the findings of Bohl et al. (2013), a study highly related to ours, where the authors apply a four-factor asset pricing model to renewable energy stocks in Germany. Their results suggest that while renewable energy stocks earned considerable risk-adjusted returns between 2004 and 2007, the performance has deteriorated significantly, delivering negative returns since 2008. We argue that a state-space model provides a more appropriate approach than a standard static CAPM-type or multifactor model to investigate the driving factors of renewable energy stocks. The applied approach might also be superior to a vector-autoregressive model as it is implemented in Henriques and Sadorsky (2008) or Kumar et al. (2012), since these models do not allow for time-varying coefficients. The time-varying nature of the relationship between oil prices and renewable energy stocks is also evidenced by the observed structural change in late 2007 (Managi and Okimoto, 2013) or the time-varying correlation structure as suggested by Sadorsky (2012).

Importantly, our applied multi-factor framework also allows for an analysis of *abnormal* or *active return* of renewable energy companies, i.e. the performance of the renewables sector relative to its identified pricing factors. The techniques applied in previous studies such as Henriques and Sadorsky (2008), Kumar et al. (2012), Sadorsky (2012) or Managi and Okimoto (2013) only allow for a limited interpretation with respect to the important issue of the performance of the renewables sector relative to other equity markets. Note that Bohl et al. (2013) also apply a multi-factor asset pricing model with time-varying coefficients to returns of renewable energy stocks. However, the study focuses on the German market only and the authors restrict themselves to applying typical pricing factors in financial markets such as factor-mimicking portfolios for size, value and price momentum, see e.g. Fama and French (1993) or Carhart (1997). Also, unlike our analysis, the study does not include variables such as energy prices or returns from technology stocks.

Finally, we also significantly extend the time period considered in previous studies (Bohl et al., 2013; Henriques and Sadorsky, 2008; Kumar et al., 2012; Managi and Okimoto, 2013; Sadorsky, 2012) by using a data set up to 2014 that includes observations for the period of the global financial crisis and beyond.

The remainder of the paper is organized as follows. Section 2 provides a brief review of recent developments and trends in the renewable energy sector and the WilderHill New Energy Global Innovation Index. It also provides a motivation for the suggested framework and explores the data used in the empirical analysis. Section 3 deals with the implementation and estimation of the applied multi-factor model with time-varying coefficients. Section 4 provides our interpretation of the results and compares our findings to other major studies in the field. Conclusions and suggestions for future work are presented in Section 5.

2. Background information and data

2.1. Trends and recent development of renewable energy markets

Renewable energy has experienced an impressive overall development in the last decade. Global investment has risen from $46 billion in 2004 to over $160 billion in 2009, as is summarized in Table 1. As a result, renewables accounted for 7% of global power capacity in 2009, up from 4% in 2004 (excluding large hydropower, UNEP, 2010, p. 12).[5]

This increase was also facilitated by expansionary fiscal policies and government established long-term targets for renewable energy, which made private investments into the sector more attractive (Justice, 2009; REN21, 2010; UNEP, 2010). The global recession led some of the world's major governments to implement expansionary stimulus packages, with significant funds going to the renewables sector. It has been estimated that about $188 billion from these packages has been allocated to renewable energy and energy efficiency in 2008; the greater part of these stimuli was expected to be spent in the 2010–2011 period.[6] In addition, most governments in the world have adopted ambitious renewable energy targets for the next fifteen years. According to statistics elaborated by REN21 (Renewable Energy Policy Network for the 21st Century), by early 2010 more than 100 countries had renewable energy target policies; this figure compares to 55 countries in 2004. Some of these targets are remarkable. For example, renewable energy targets

[4] Source: www.nexindex.com. Accessed: September 2013.

[5] The UNEP's (2010, p. 12) 'narrow' definition of renewable energy includes production from industrial plants. Using an alternative 'broad' definition, REN21 (2010, p. 15) suggests that nearly 19% of global final energy consumption in 2009 was provided by renewable energy. This 'broad' definition includes traditional biomass which accounts for 13% of the supplied figure. 'Traditional biomass' refers to resources used mostly in developed countries that require no or little industrial value added (for example, burning wood for cooking and heating purposes). The definitions of renewable energy investment in Table 1 exclude traditional biomass which is irrelevant for our purposes.

[6] Source: REN21 (2010, p. 27). The combined $188-billion stimulus packages referred to are expected to be spent progressively over the period 2010–11. This is due partly to government's administrative barriers and partly to the research that needs to be done before investing in new renewable energy plants (for instance, the optimal location and operational timing of a new energy plant that connects to an existing electricity network require careful study).