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Is carbon emissions trading profitable?

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ABSTRACT

The European Carbon Emissions Trading Scheme introduced in 2005 has led to both spot and futures market trading of carbon emissions. However, despite seven years of trading, we have no knowledge on how profitable carbon emissions trading is. In this paper, we first test whether carbon forward returns predict carbon spot returns. We find strong evidence on both in-sample and out-of-sample predictability. Based on this evidence, we forecast carbon spot returns using both carbon forward returns and a constant. We consider a mean-variance investor and a CRRA investor, and show that they have higher utility and can make more statistically significant profits by following forecasts generated from the forward returns model than from a constant returns model.

1. Introduction

1.1. Background

The European Union in January 2005 formed the EU Emissions Trading Scheme (EU ETS) in order to assist the member States to combat climate change under the Kyoto Protocol. The Scheme has a number of trading phases. The first ETS phase was announced over the period 2005–2007 and the second phase covers the period 2008 to 2012. The third phase began in January 2013 and will go up to 2020. This scheme is commonly known as "cap-and-trade" scheme. It allows a legal limit on the quantity of carbon emission (or greenhouse emission) that a country can emit each year. This scheme was responsible for the establishment of both the spot and futures markets—a mechanism for discovering the market price.

In March 2005, the futures contracts were announced on the European Climate Exchange (ECX). The Intercontinental Exchange (ICE) cleared trades on the ECX. This also hosts the electronic marketplace for the Chicago Climate Exchange. The ECX introduced certified emission reduction (CER) futures and options in March 2008, and it introduced an EUA-CER spread trade in October 2008 (see Bredin et al., 2014[1]).

As noted by Mizrach (2012), the futures contracts account for 75% of the volume trades in EUAs. Moreover, Arouri et al. (2012) document that a new class of carbon investors has emerged with the creation of the EU spot and futures markets. This is due to the fact that the carbon asset and related derivatives can now be used for different investment operations, such as portfolio diversification, arbitrage, hedging, and speculation. The carbon futures markets are of particular interest due to their crucial role in facilitating risk mitigation and transfer among market operators, and helping the price discovery process in the spot markets (see for instance Arouri et al., 2012; Milunovich and Joyeux, 2007; Schultz and Swieringa, 2014).

In light of the introduction of the carbon emission futures market, two issues have come to the fore. First, futures markets are perceived as playing the role of price discovery—that is, the futures market reflects new information before the spot market does. Therefore, the question that comes to mind immediately is: does the carbon futures market, because it is expected to contain new information, predict the carbon spot market? Thus, the first contribution of this paper is that it uses daily time-series data for the period 2010 to 2012, and fits a predictive regression model, where the null hypothesis is that carbon forward returns does not predict the carbon spot return.

The second issue is: if the carbon futures market is, indeed, reflective of new information such that it helps predict the carbon spot returns, can it allow investors to potentially devise trading strategies based on forecasts for carbon spot returns? We study this aspect of the carbon emissions market in detail. Our approach is as follows. We first undertake a rigorous out-of-sample forecasting analysis, comparing the predictive ability of carbon forward returns with a constant returns model. The constant returns model is the workhorse of the literature and, in financial economics, particularly with regard to the literature on forecasting, has turned out to be a popular and competitive benchmark model (see, *inter alia*, Welch and Goyal, 2008). From this exercise, we discover two things: (a) the carbon futures-based predictive regression model outperforms the constant returns model at both short and long-horizons; and (b) using a relatively more robust test of excess profitability, developed by Anatolyen and Gerko (2005), we ascertain

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[1] A very recent study by Bredin et al. (2014) provides a very informative and detailed discussion on the recent developments in carbon finance, which includes both carbon spot and futures market. Thus, to avoid repetition of this discussion and to conserve space, we provide very minimum discussion on this here. Interested readers are referred to Bredin et al. (2014).

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the information content of carbon futures over a constant returns model. That carbon emission futures returns is able to predict carbon spot returns much better than a constant returns model, implies that an investor can use carbon futures to forecast carbon spot returns and devise trading strategies.

Finally, we assume both a mean-variance investor and an investor with a constant relative risk aversion (CRRA) utility function. We show that both types of investors enjoy higher utilities from forecasting spot returns using carbon futures, compared to when they generate forecasts using a constant returns model. We also estimate profits for these two types of investors based on forecasts generated from the two types of models. We show that while profits from both the constant returns model and the carbon futures model are statistically significant, they are much higher from a carbon futures model.

1.2. Literature and contributions

There are three main strands of the literature on carbon emissions. The first strand focuses on the relationship between carbon prices and other variables, such as the price of electricity or price of power and gas (see for instance, Aatola et al., 2013; Veith et al., 2009; Prete and Norman, 2013), the stock returns (see inter alia, Veith et al., 2009; Oberndorfer, 2009), oil and energy consumption (see Kumar et al., 2012; Sadorsky, 2009; Zhuang et al., 2014), and other macroeconomic variables such as GDP (see Chevallier, 2011; Lutz et al., 2013). One common feature of these studies is that they typically use carbon spot or forward prices at the daily frequency, except in the case of Sadorsky (2009) and Kumar et al. (2012), where they use data at the annual and weekly frequencies, respectively.

The most common econometric approaches used by these studies are OLS, GARCH, cointegration, and Markov-regime switching models. The findings from these studies are as follows. Aatola et al. (2013) document that the EUA forward price depends on the price of electricity and the gas–coal difference. Veith et al. (2009) show that returns on common stock of the largest affected industries, power generation are positively correlated with rising prices of emissions, whereas Prete and Norman (2013) do not provide empirical evidence of a statistically significant difference in the response of power prices to positive and negative shocks in carbon price. Additionally, Oberndorfer (2009) finds that the EUA price changes and stock returns of the most important European electricity corporations are positively related whereas Kumar et al. (2012) find no significant relationship between carbon prices and the stock price of the clean energy firms.

The second strand of literature is based on the development of the carbon spot and futures market, where the difference between the efficiency of the market in Phase I and Phase II is identified. For instance, Creti et al. (2012) investigate the determinants of the carbon price during both phases of the European Union Emission Trading Scheme. They use cointegration techniques and document that while a cointegrating relationship exists for both phases of the EU ETS, the nature of this equilibrium relationship is different across the two phases. They note an increasing role of fundamentals in Phase II and show that the carbon price tends to be undervalued at least since the end of 2009. Daskalakis and Markellos (2008) examine the efficiency of the European markets for carbon emission allowances during Phase I using technical analysis rules and naïve forecasts. Their empirical results indicate, using several econometric procedures and trading strategies, that the behaviour of the three predominant EUA exchanges under the EU ETS (European Climate Exchange, Nord Pool, and Powernext) is not consistent with the weak form market efficiency. The authors explain their findings by the immaturity of the EU ETS as well as the restrictions imposed on the banking and short-selling of emission allowances. On the other hand, Milunovich and Joyeux (2010) find evidence against the existence of a long-run relationship between EUA spot and futures prices in Phase I. Their results are consistent with the findings of Chevalier (2010) for Phase II of the EU ETS. Chevalier (2010) rejects the long-run relationship between CO_2 spot and futures prices with respect to linear cointegration tests, but finds that futures prices are relevant for price discovery in the spot market. Furthermore, Rittler (2012) models the relationship of European Union allowance spot and futures prices within the Phase II period of the European Union Emissions Trading Scheme. They analyse the transmission of information in the first and second conditional moments using daily as well as intraday data at the frequencies of 10 and 30 min. They find futures market to be the leader in the long-run price discovery process. Additionally, their analysis on the volatility transmission structure reveals a close relationship between the volatility dynamics of both spot and futures market. They also observe that volatility spill overs from the futures to the spot market. Additionally, Arouri et al. (2012) examine the dynamic relationship between the EUA spot and futures prices during Phase II. They use a VAR model and the switching transition regression-exponential GARCH models and show that carbon spot and futures returns are asymmetrically and nonlinearly linked.

The third strand of the literature looks at the predictability and profitability of the carbon spot and futures markets. This related to our work but with substantial differences in terms of issues covered and approaches employed. Consider, first, the study by Paolella and Taschini (2008). They consider only the carbon emission returns series, employing daily data covering just over 400 observations and test the forecasting ability of a range of GARCH-type models. There are two main differences between Paolella and Taschini's (2008) and our study: (a) we test for both predictability and forecasting ability and we consider the carbon emission forward returns as a predictor of carbon spot returns; and (b) we devise trading strategies on the evidence that carbon forward returns predict carbon spot returns, and show how investors with different utility functions can potentially make use of information contained in the carbon futures market and make non-negligible profits.

In a relatively recent paper, although much different from our work, Rittler (2012) examines price discovery and volatility spillovers in the European Union Emissions Trading Scheme. One finding from this study—that the futures market incorporates information first and then transfers the information to the spot market—has direct relevance to our first research question of whether or not carbon forward returns predict carbon spot returns. Given Rittler's finding, we should find predictability, and we do. But, then, we do not stop there. We explore how investors can devise trading strategies and make profits. Therefore, our study can also be seen as extending not only the work of Paolella and Taschini (2008) but also that of Rittler (2012). Finally, in a relatively earlier work, Daskalakis et al. (2009) model carbon emission allowance prices and derivatives. Their main focus, unlike our work, is on the pricing and hedging of intra-phase and inter-phase futures and options on futures under the European trading scheme.

In light of these discussions, the contribution of our study is twofold. First, we undertake an in-sample and out-of-sample predictability and forecasting performance of the carbon spot market. We find that carbon forward returns predict carbon spot returns both in-sample and out-of-sample. We find that this evidence of predictability is robust to the use of different estimators and forecasting horizons. Second, we devise trading strategies for two types of investors—a mean-variance investor and a CRRA investor—and show that by utilising information contained in carbon futures, investors not only obtain higher utility (as measured by the certainty equivalent return) but also make higher profits compared to a model where forecasts are generated from a simple constant returns model. On the whole, both statistically and economically, the carbon futures-based predictive regression model consistently beats the benchmark constant returns model.

The rest of the paper is organised as follows. In the next section, we discuss the theory that motivates the empirical analysis, and explain our estimation approach. Section three discusses the data and the main findings. The final section provides some concluding remarks.